British Society for the Study of Orthodontics.

1926

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TRANSACTIONS

OF THE

British Society for the Study of Orthodontics

1926

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1926

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The Meetings are held at the Rooms of the Medical Society of London, 11, Chandos St., Cavendish Square, W.1.

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The British Society for the Study of Orthodontics

An ordinary meeting of the Society was held at 11, Chandos Street, Cavendish Square, W.1, on January 18th, 1926, Mr. G. F. Cale Matthews, President, in the chair.

The minutes of the previous meeting were read and confirmed.

Mr. Pain and Mr. Visick were formally admitted as members of the Society by the President.

The following candidates for election were unanimously elected members on a show of hands : P. Lloyd Williams, L.D.S., M.R.C.S.Eng., L.R.C.P.Lond., 128, Harley Street, London, W.1 ; C. Everard, L.D.S. Sheffield, 87, Worple Road, Wimbledon, S.W.19 ; Freda Mary Andrews, L.D.S.Eng., 4, Cresswell Road, East Twickenham ; Fred Rous Mallory, L.D.S.Ontario, D.D.S.Toronto, 30a, Wimpole Street, W.1.

The President read the following paragraph from the Agenda : "Immediately before the President delivers his Inaugural Address, the meeting will be made a Special Meeting (to comply with Rule XLVII) for the consideration of 'Smoking during the Meetings.' The President announced at the last meeting that this matter would be put before the Society as a whole for decision." That decision was in the members hands. It appeared to be the desire of the Council that smoking should not take place until after the paper of the evening. Was it the wish of the members that such should be made a Rule of the Society ?

A vote by show of hands was then taken, which showed that the members were in favour of smoking not being allowed until after the paper of the evening had been delivered.

Invitation to the International Orthodontic Congress.

The President then read a letter from Dr. Spahn expressing the hope that the members of the B.S.S.O. would endeavour to attend the Orthodontic Congress in New York, where every effort was being made for their comfort and entertainment.

The President then delivered his Inaugural Address.

Mr. Badcock said it was with the greatest pleasure that he asked the members to accord a very hearty vote of thanks to the President for his very able, interesting and stimulating Address. The members had all enjoyed it, and it would give them all a great deal of food for thought. He trusted that at the end of his year of office the President might perhaps see the Society go a little way on the path that he had marked out for it.

Mr. H. Chapman seconded the motion, which was carried with acclamation, and the meeting then terminated.

At a meeting on Monday, February 1st, 1926 (Chairman, Mr. G. F. Cale Matthews, President), the following members signed the Obligation Book and were formally admitted to the Society : Messrs. C. Everard, V. A. F. Greenish and P. Lloyd Williams.

The following were elected members of the Society by a show of hands ; Adeline M. Matland, L.D.S., M.R.C.S.Eng., M.B.B.S., L.R.C.P.Lond., 75, Moorgate, London, E.C. ; Edna F. Crampton, L.D.S.R.C.S.Eng.,

108, Chatsworth Road, Willesden Green, London, N.W.2 ; Beryl L. Allen, L.D.S.R.C.S.Eng., King's College Hospital, Denmark Hill, London, S.E.5 ; R. N. Bragg, L.D.S.R.C.S.Eng., 60, Barrington Road, London, S.W.9; L. Russel Marsh, L.D.S.R.C.S.Eng., 14, Lancaster Gate, London, W.2 ; Hyman Middleburgh, L.D.S.R.C.S.Eng., 44, Sackville Road, Hove, Sussex.

BRITISH SOCIETY FOR THE STUDY OF ORTHODONTICS.*

By G. F. Cale Matthews, L.D.S.

To be elected President of the B.S.S.O. constitutes a great honour, and I thank you most sincerely for according me this position, and crave your indulgence for any shortcomings in conduct of your meetings. Our late President earned the honour and our gratitude, by many years of hard and conscientious service as Secretary, and right well has he acquitted himself, and it is to him and the Executive the immediate President must look for help and guidance.

The year of Presidency soon passes, and the influence of such an office cannot compare with that of an efficient Secretary, which this Society has had and has the very good fortune to possess. We are living in a time when the call is all for Nationalism—a time when the consequences of a world upheaval have caused the nations to examine their resources—to consider the possibilities of their future existence in the case of the smaller ; and to put forth, in the economic struggle for existence, a wider sympathy for mankind in general.

The title of this Society was adopted by its founders possibly without any very serious consideration of its magnitude. If we consider for a moment, we shall perhaps be rather surprised at the title: "The British Society for the Study of Orthodontics."

If the responsibility of such a title is analysed, we must acknowledge a very heavy one, for from the national professional outlook it must naturally be the authority which should guide and develop orthodontic practice and teaching. Fortunately for us such grave responsibility does not exist in one sense ; professional practice knows no nationality—we have the advantages of international communication, the free interchange of thought and culture, the collaboration of the greatest students of research, and practical methods for the advancement of orthodontics—still, in our domestic policy, we

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Since this address was delivered the first Orthodontic Congress has been held in New York. This is an event of very considerable importance. Dogmatism has departed from the attitude of the orthodontist of the past. Every regard is given to the practice and ideas of the individual who can show a scientific reason for his treatment, and whose treatments are justified. I was more than gratified by the reception of the English visitors, because we have always been led to believe we are behind in the study and practice of orthodontia. Such an opinion is not to be any longer held. Our methods may be different, our problems are the same but must be approached in a different way. Economically and nationally we must approach this subject from a different standpoint to our American confrères, remembering always that the results of our investigations are to be universally applied. Those of us who attended await the publication of the *Transactions* of the Congress with eagerness.

* *Transactions*, Jan. 18th, 1926.

must shape our progress. Gradually conviction is growing that orthodontics is not only a useful, but a very necessary part of dental practice ; it may be perhaps excluded as dental practice and regarded as the demand for special treatment as the natural outcome of ever recurring and increasing malformations, due to causes which are being examined more carefully on the basis of scientific knowledge ; and that its practice could be undertaken on a curriculum which would eliminate some of the time spent on prosthetic and conservation work—thus allowing more time to the student to perfect himself in the actual subjects more closely allied to orthopraxis.

Both our national and professional conservatism would hesitate to accept such a revolution, but I have little doubt the future must see some change in the curriculum, and possibly at a not very distant time. The present curriculum of the student is so full that the study of orthodontics is, in many cases, avoided as far as possible, and it seems impossible to allow more time ; the consequence being the student qualifies with less knowledge, both practical and theoretical, in this subject, than in any other of his syllabus. And how is this to be corrected ? The very exhaustive report of the Education Committee of this Society has set forth an admirable scheme for the guidance and instruction of craftsmen in orthodontics, but it is more than that : it is a guide to the schools for the instruction of students, and is so arranged that all schools of thought and practice may find assistance.

Membership of Societies devoted to branches of medical science may invoke any degree of enthusiasm from that of spectator to an earnest and active participant in its activities. It is my hope that during this coming year the active part will be taken by an increasing number, and particularly of the younger generation. It is a privilege of seniority to assume that the succeeding generation is not so alive to its duties as occasion demands, but we know that this is a characteristic grumble which has no foundation in fact. The young generation is keenly alive to its responsibilities, and happily there is a keener competition, which must make for good. Perhaps the great defect in our national professional life is the lack of competition. It is possible for the young dental surgeon to make a sufficient income despite the fact that he is educated like a K.C. and paid like a plumber, and the way can be made easier for him by the appointments on the various clinics and the public dental service, which avoids that long period of starvation and anxiety to which so many have been subject in the past. This may militate against the further study necessary to fit a man for the specialisation practice, such as orthodontics. It is the duty of such a Society as this to enthuse the younger generation until such time as the awakening occurs. The papers read here from time to time are making history ; the very valuable research work revealed has already had a marked influence on orthodontic thought and procedure, but there must be no slackening in the immediate and active treatment of the patient requiring attention. Sceptical criticism and abstention of present practice will harm no one but the children who should have treatment ; and we must remember that despite our acknowledged deficiencies in etiology, sufficient is known to establish a very real and helpful practice.

Nero fiddled while Rome burned; we cannot wait for all the knowledge that will doubtless come—the child must be treated. The B.D.A., as the result of Mr. Samuel's paper in May, 1925, has appointed a Committee to examine the possibilities for a scheme for the orthodontic treatment of school-children, and although the report will belong to the B.D.A., both the members of that Committee and the evidence will come largely from this Society. It is possible that centralisation of a Society's activities may militate against its usefulness, but that is unavoidable, and we know from many experiences, particularly the series of lectures organised by the Dental Board, how poorly special lectures can be attended. This, let us hope, does not denote a lack of interest, but a very real difficulty due to the environment of a practice and the economic problem.

The endeavour to establish a mechanical system of diagnosis which will lead to a perfect method of treatment is occupying many orthodontists' minds at present. Anthropometric measurements—cephalometric methods and apparatus—muscular developments—are to give us the key to a correct solution. At present my opinion is that many abnormalities of occlusion are so influenced by heredity, environment, feeding, habits engendered by imitation, mixed racial characteristics, as to be beyond the possibility of universal treatment through any mechanical diagnostic appliances. Should such a possibility become real we should welcome it joyfully, but it suggests the mechanical humans of Karel Capek's play R.U.R.

Still we are the creatures of fashion even in our practical work—good if the fashion is a good one—the present evolution of lingual arch treatment, and the almost entire neglect of the older and well tried methods is an example and an advance; but it requires a higher degree of skill and more experience than its predecessors, and probably another method may be evolved, which will render our present practice more or less obsolete.

If there is a note of pessimism here you must pardon me. I have personally suffered a disability which has exercised the great orthopædic minds from Hunter to the present day, and the advance has been very slight in treatment and mechanical assistance during that period. The treatment of an individual limb should be simple in theory compared to the complexities involved in a serious case of malocclusion. There is no actual analogy between the etiology of antero polyomyelitis and malocclusion, but both are in the sphere of orthopædic surgery; and we may still be only at the commencement of our knowledge. Our speciality is young, its advance has been very rapid, and magnificent results are being obtained, in some cases empirically (using that word in its best sense), and we look to those who have the time and research sense to advance us on the way to a truer knowledge.

It is unfortunate that the questions of nomenclature and classification have not yet been settled. It seems to me that whatever the classification adopted—either Lischer's, Bennett's or Angle's, to name only three—Angle's is the one most generally used, and it is more or less inevitable. It is difficult to depart from the early teaching. The analogy is almost that of learning a foreign language: thinking in one's own and speaking in the other until quite familiar with both. To the majority the immediate mental picture at once

conjured is that of Angle's classification, and a *re*-solution from that to whatever is the chosen one, requires some effort. I would like to impress the great necessity of insisting on jaw relationships in classification, and endeavouring to establish in the minds of students a complete and definite image of the distinct variations—eliminating for the preliminary diagnosis, the individual positions of the teeth—thus establishing a correct method of, and a fundamental basis for, the fine points of adjustment in the relation of the occlusion of the teeth.

Orthodontic practice is concerned with the growth and building of the temporary and permanent denture and its related parts—thus it has to deal with the child. There comes again a time when all the teeth are lost and we have the edentulous mouth. Can we relate the condition of the infant maxillæ and mandible to that of the aged? It would be incorrect, I think, to judge relationship from cases up to middle life where teeth have been removed unequally, and where the necessary absorption to establish the comparison has not occurred and may never do so, the study of the relation of the maxillæ and mandible in the edentulous aged may be of considerable help to the orthodontist, by a comparison of what has been established and then lost. There is permanent forward growth of the bone remaining, but the alveolus has been absorbed—which brings the condition to the same relationship in the comparison to the general growth of the head and face. While an establishment of occlusion will have resulted from the presence of the teeth, on their subsequent loss that occlusion must be accurately re-established if the patient is to be comfortably fitted with artificial substitutes. We know how difficult this may be. This thought has no claim to scientific orthodontic usage. It will be found that the same condition remains in the relation of the edentulous as existed in the complete denture whether it be normal, distal or mesial, and that the articular relationship will remain stable. Due allowance must be made for the development and retention of feature prominence or otherwise, which may or may not have responded to the dental development.

Much work and study remains to be done in the etiology of malocclusion, and foremost in this work I would place heredity. Confusion is growing around the terms of heredity and environment; they may be taken together and their combined significance duly noted, but they should remain separate and distinct units of comparison for the dissection of essentials. The outstanding indication in the historical evidence of heredity is so frequently quoted from the Hapsburgs and Bourbons—in the one case the lower lip, and the other the nose. Those are the evidences which are obvious and revealed, but there may be others which could only be recorded by an examination involving both detailed and private research.

The student of orthodontics, after his curriculum is completed, may direct his attention to many studies: the anatomy of the parts, the etiology, the quest in diagnosis for the treatable—and ultimately the practical solution of the problems presented. Unfortunately, it may be his inclinations and opportunities do not lie in the direction of these advances, and circumstances may so tend that they shall be taken in an inverse order. The artistic side of our work does not receive the attention it deserves in dis-

cussion at meetings. The general and almost universal procedure is one of pure mechanical knowledge and activity, whether that be muscular or technical.

There is another side which should be cultivated—a side which must be helpful—the truly artistic appreciation of nature, whether it be in the human development or in the limitless field of nature; it will widen the powers of observation and help in the relation of values. A musician would not attempt to write a symphony until he had mastered the elements of harmony, counterpoint or orchestration. The artist will study in detail the subject he wishes to describe in colour; sketches innumerable may be necessary before he is satisfied that his resulting picture will describe his subject correctly, not only in drawing but be true to form—values correctly related.

The great artistic masterpieces of the centuries have all one outstanding feature: they are true in tone, they convey a sense of harmony, and they exhibit a profound and keen observation. We are not all of us gifted with the artistic sense—we may have no musical sense or artistic perception, but we can all encourage the faculty of observation; and I do commend to those who have any desire to become proficient in the art, for art it is, of orthodontics, a study of the beauties of art and nature. The great galleries are full of lessons for us. We see through the centuries the gradual change of facial development, the change of facial depiction of national characteristics, and we can add to our anatomical studies and knowledge the additional fact that heredity and environment do make changes of expression through time and circumstance. We must, however, be always on our guard to make proper allowances for fashion.

From time to time there are indications of a sincere desire for increased instruction by post-graduate work. While this method of teaching has great popularity in the U.S.A., it seems to be against our national inclination to acknowledge the necessity for further instruction once the hall-mark of qualification is obtained. Why is this? The answer is a difficult one, and I find myself back again at the "competition" stage.

If post-graduate work is not a necessity it cannot be a success; the combination of a few earnest students in a request for such courses will make for efficiency and knowledge in both student and teacher; but its efficiency must be based on a proper appreciation of its value, and it must be a properly remunerated course of instruction.

The many varied post-graduate courses in America cost as much for three months' training as the whole of our curriculum fees in many cases, eliminating the mechanical training. Not only are they fully attended, but the student is expressly reminded that he will need much clinical experience before he should embark on practice.

This coming summer those of us who go will have opportunities in the International Congress of judging how comparable are the methods of teaching in the ordinary curriculum; but unless we adopt some further instruction than can be given during the present studentship it must be a long period between qualification and successful orthodontic practice for many. Can the B.S.S.O. initiate

any such courses? Can the attendance at such courses be a recognition of capacity? Such an acknowledgment of capacity will be advantageous to all concerned—it would enable the orthodontic practitioner to have his cases inspected, and appliances adjusted by others with confidence that a clear understanding existed as to diagnosis and treatment of that particular case.

A Presidential Address should have a note of originality. It was my hope to present to you some records of comparison in feeding and malocclusion: this proved a greater task than I anticipated, and so far the figures obtained would not justify publication. The results aimed at are the definite establishment of pre-natal feeding effect on bone formation, and the comparison of all classes of the community from the frugal, bare necessities to luxury in feeding. The general history chart of the B.S.S.O. does this from 1-6 years with the child, but I wish to carry this further to the parental responsibility. It is proving a tremendous task, and may take some years to establish any reliable relationship.

Extra orthodontic education consists of two principal factors: the education of the parent and the education of the public authorities. The number of children who would benefit by some thoughtful treatment varies according to various writers. Mr. C. E. Wallis states that 2 per cent. of the children in the London school area need treatment. Mr. Norman Bennett gives the figures as 9 per cent. needing simple treatment, in his Report to the Ministry of Health. Mr. Jones, the Dental Officer of Staffordshire, gives 6.6 per cent. If we take an average of these figures and accept 5 per cent. as a fair basis from the official standpoint, and a low estimate of 500,000 children, we have the appalling figure of 25,000 children needing orthodontic treatment, in the number of children who come under the dental officers' care for examination and treatment for caries, etc. This does not include the great number who are both too young and too old for dental examination. The figure of 5 per cent. is by no means a fair proportion based on one's clinical experience. The figure must be based on a broad appreciation of malocclusion, and if so, would probably be between 30 per cent. and 40 per cent. But if you allow 25 per cent. we have over 100,000 children needing attention in London alone. At present these children go untended by any authority—the schools do their best—it is a mere drop in the ocean of responsibility. In the past there has been some excuse for this neglect: lack of dental surgeons willing to do the work, a misgiving as to its practical outcome, and lastly the cost. Expense of public treatment must always be considered, and it never grows less. The other difficulties, lack of dental surgeons and the doubt of successful practice, do not exist in anything like the same degree. I am assured that many of the school dental officers would welcome the opportunity of being allowed to do orthodontic work, and the increase of young practitioners should supply an efficient service, and the results should more than justify the cost. I was interested to read the remarks of that amusing and cultured writer, Mr. E. V. Lucas, in an article in the *Sunday Times* of December 13th last, "American Notes from a Wanderer's Note Book."

"In every city that I visited—whether New York or Pittsburg, Cincinnati or St. Louis—I was struck by the prettiness of the girls

and the excellence of their clothes. In New York there are more of them, that is all; in the other cities the standard of dress is as high. . . . And how refreshing it was to find girls with chins once more, after our prevailing English type, where, in accordance with I know not whose dictates, the chin has for so long been removed."

This remark from a layman, in reference to the revival of the chin, is interesting. It is a remarkable statement from the orthodontist's point of view. We know that distocclusion is a very common form of malocclusion in America, as frequent as in this country probably, and yet to the casual observer the chin is reappearing in the American girl. If this is the result of orthodontic treatment as practised there it is a compliment to our speciality and American colleagues, and it behoves us to examine this in a more scientific way. Nevertheless, it should be noted. Can the B.S.S.O. give any assistance to the nation in dealing with a subject so vital to its health and beauty? I venture to think so, but it must be approached in a spirit of sacrifice if embarked upon. As I have said earlier in these remarks, the suggestion is made from time to time that post-graduate courses should be available in orthodontics. Some such courses have been held, and with some good results to those attending, if only to give them a knowledge in the time sufficient to enable them to view the subject in a different light to that gained in a compulsory syllabus as students. Every recruit is to be welcomed, but it has hardly touched the fringe of the subject. For one reason, the courses are usually given by one individual. It is difficult for a single lecturer or operator to teach in a course of twenty hours (ten lectures so called) a subject with so many ramifications as orthodontics. We know, from our experience in this Society, how popular an evening devoted to practical demonstrations is, and interesting and instructive they are, but that is the great danger in orthodontic teaching: the fascination of beautifully designed appliances must appeal to the mechanically trained sense of the average dental surgeon, and having assured himself that an appliance can accomplish a certain movement he may be impelled to employ it without having fully acquainted himself with its possibilities, sometimes to his great disappointment.

To the student and practitioner of orthodontics, I venture to suggest many things evolve from a subconscious familiarity, in other words, experience and skill—two things it is impossible to teach. I find in conversation with orthodontic practitioners of renown that their practice has generally been built upon a solid foundation of general practice, and that the specialisation has come along with, and after many years of, such experience. Our national characteristic of caution and compromise has, during the past twenty years, allowed us to gather a fund of knowledge, sometimes at the expense of our more enthusiastic and venturesome brethren, to whom we are indebted for the opportunities afforded us. No-one, to-day, would venture to allow to a universal application of an individual appliance, the possibility of correction of all types of malocclusion, yet such claims have been made for many forms.

The work of the B.S.S.O. is varied. It has its purely academic interest as evinced by the high standard of its papers of great scientific value, which will gradually give authority to treatment. It has its educative side in that we all as members must benefit

by our mutual association and exchange of thought and practice, and it has its still further sphere of usefulness in that its transactions are freely published for the benefit of humanity in general. But neither the academic interest or educative value should be the total asset to the nation of a Society such as this. Being the only Society in the British Isles devoted to the study of orthodontics, I venture to suggest to you a scheme which should add much to our knowledge and materially add to our national welfare. One can assume that it is impossible for our schools with their honorary staffs to undertake the task of post-graduate orthodontic teaching. It is also recognised that the students' curriculum is fully loaded. It is a fact that there is a sufficiency of able and earnest teachers if the occasion arises. It can easily be ascertained if there is a probability of a genuine desire for this teaching. The clinical material is available and demanding treatment, and would be passed through the school clinics only. London should be the centre for such work. I would like to see a permanent school devoted to the teaching of orthodontics established; facilities should be granted to enable it to become firmly established. It should be enabled to grant a diploma of proficiency to those students fulfilling the requirements of its syllabus and examinations, and it should be established under the auspices of the B.S.S.O.

A CLEFT PALATE CASE.*

By H. C. Highton, L.D.S.

I THINK perhaps I ought to apologise for bringing before you this evening a communication which is not strictly an orthodontic case, but as it is connected with development I thought it might be of interest. A cleft palate is due to an arrest of development and may involve the hard and soft palate. The consequences of cleft palate in infancy are that suction and deglutition are seriously interfered with. The infant as a rule is unable to take the breast in an erect or semi-recumbent posture and must be fed with the mother's milk by a spoon passed well to the back of the mouth, or by a feeding-bottle with a large teat to act as a plug to the cleft. The operation for the cure of the deformity, I understand, is better not done in infancy, as some advise, since bleeding is then badly borne and the cleft, at least of the bony palate, diminishes in width during the first two or three years of life. Infants moreover are liable to catarrh of the pharynx and lungs, and coughing and sneezing tends to tear the parts asunder.

The case I wish to bring before you this evening is that of a firstborn child, which I believe is the common type, and in this particular case the cleft involved the soft palate only.

The child was born November 12th, 1924, and weighed 10¾ lbs. at birth, and the history from birth until the first attendance at the clinic was that the child had had a slight tonsilitis and refused to take anything but the breast, the child suffered from nervous

* *Transactions*, Jan. 18th, 1926.

unrest, and the discipline had gone to pieces. The mother attended the clinic with the child for the first time on December 16th, 1924. The child was said to have lost 3 lbs. 10½ ozs. since birth and was obviously very wasted. The cleft palate was only discovered by the mother three days before attending the clinic. The suction had always been poor and the breast milk had been squeezed into the baby's mouth. No other method of feeding had been used. The case was referred to the ward for re-establishment of breast feeding. On December 18th the child was taking ⅜ oz. of milk in twenty minutes. The average amount of breast milk was 1½ oz., the breast feed being supplemented to 3 ozs. with expressed milk, and cow's milk and water, given with a spoon ; the mother having breast massage and hot and cold sponging. At the end of December, 1924, an impression was taken, a guess being made at the size of the tray required, a small amount of impression material being used and the excess squeezed into the cleft with the finger. A special tray was then made from the model obtained. Another impression was then taken with the special tray and a vulcanite case made with an obturator extension into the cleft and the case inserted on January 5th, 1925.

On January 6th the obturator was used for the first time during the feeds, and the child took 1¼ ozs. of milk in twenty minutes. The average amount of breast milk was 3¼ ozs., the breast feeds still being supplemented with cow's milk and water. On January 14th the child was taking 2¼ ozs. in thirty minutes ; the average amount of breast milk was 4½ ozs. The supply of breast milk was now sufficient without giving cow's milk. January 22nd 4¼ ozs. was being taken in thirty minutes ; the average amount of breast milk was 5¾ ozs. The child was still needing a small spoon feed to make feed up to 4½ ozs., the extra amount of breast milk being given to help feed another ward baby. On January 28th 3⅜ ozs. being taken in thirty minutes. Average amount of breast milk 5¾ ozs. February 4th 5 ozs. being taken in twenty minutes. Average amount of breast milk 6⅛ ozs. February 11th 5 ozs. in fifteen minutes. Average amount of breast milk 6¾ ozs. On February 12th, 1925, the case was discharged from the ward. On discharge the baby was sucking well and taking a full feed of 5 ozs. from the breast in fifteen minutes with the help of the obturator. This was an easy case of re-establishment of the breast milk supply, and the mother responded well to treatment. She expressed about 1½ ozs. more milk than the baby needed after each breast feed. Subsequent obturators were made at intervals varying from seven to ten weeks, and as shown by the chart the child continued to make good and normal progress. I ought to state that the obturator was only worn when the child was fed, afterwards being removed and cleaned and re-inserted by the mother for the next feed. I know that several of the members have had a great deal of experience with cleft palate cases, and I am hoping they will give me some suggestions which may be useful in future as I may have several other similar cases to treat, and perhaps my methods have been rather crude.

(Mr. Highton then proceeded to show a chart, models, tray, obturators, and photograph of the case.)

Discussion.

The President said as far as he was concerned Mr. Highton's case was absolutely unique in treatment, and he was sure there were members present who would like to ask questions and discuss the case.

Mr. Pitts remarked that he had had under his treatment one or two such cases. Some months ago an interesting paper on the subject had appeared in the *American Journal of the Diseases of Children*, a short note of which had appeared in the *British Dental Journal*. The article had been written by two medical men, who described their experiences of babies with cleft palate. Their experience with obturators, which they had used without much success, had suggested to them to try occluding the nose from the outside. If air passed through the nose into the mouth it reduced the pressure, and therefore a child could not get sufficient milk. The method which had suggested itself to them was the following. A strip of rubber dam was tied round the head, and passed over the nostrils. The nurse lifted the end up and down between each suction, so as to allow the child to take breath. Apparently it had acted quite well. Data were given of several infants treated in that way, which showed an increase in weight. It was obviously a very simple device, whereas the method of using an obturator in the case of a baby was far from being simple; and he would suggest to Mr. Highton that if he had another case he should try the method just mentioned. It was so very simple that it did not take up any particular amount of time, and if it failed Mr. Highton could then go on and make an obturator. In the view of the writers of the article the heavy mortality of life in cleft palate babies was really due to malnutrition owing to the fact that they were unable to get enough food; it took them so very long to get any food that their muscles became tired out. They were unable to continue for any time, and thus became under-nourished and so fell ready victims to infection. He would like to ask if Mr. Highton had made his obturator of vulcanite.

Mr. Highton replied in the affirmative.

Mr. Pitts said that in the cases he had had under treatment he had used a soft rubber, as the impression obtained was of a somewhat sketchy order, and one could not always be certain of its accuracy. If soft rubber was used, even if it did not quite fit the palate accurately he did not think it mattered very much.

Mr. Kelsey Fry remarked that he had had under his treatment about 350 cleft palate cases. He had had 60 patients within the first week of life. It was necessary to get these patients as soon as they were born, because if they were going to get the mother's milk the sooner it was started the better. If the patient came about a fortnight after birth, and the practitioner was going to make an obturator and get the patient on to the breast, that lost fortnight made the case more difficult. Whether it was a right cleft or a left cleft or a double cleft, the practitioner should carry a stock of trays. Every mouth was the same, and only four trays were needed—one for a right cleft, one for a left cleft, and one for a double cleft, the fourth being necessary where the premaxilla protruded. The legs of the child were put on the nurse and the head on the practitioner's lap. As soon as a finger was put into the child's mouth it started to cry and then in went the tray. There was no difficulty about taking the impression, because as soon as the tray was in position the child, either because it was hungry or because it thought it was getting something, sucked on the tray. The practitioner waited until he thought it was sufficiently hard; the child cried again, and out came the tray. There was no difficulty in getting an impression of a child who was one day old. It was much more difficult to take the impression of a child a year old because it was not quite so easy to handle. Having got the impression, he then made a soft rubber plate, with one strip of hard rubber

running across the palate, to give rigidity to the plate. He also put on a little metal loop, which was rather useful, because the nurse was able to tie a piece of string or silk on to the plate—as the plate required some removing when the child had had the plate in and had sucked on it. The nurse just pulled the string or silk and the plate came out. After explaining the method to the nurse it was very seldom necessary for the practitioner to see the patient again. The plate was very useful for feeding, and, what was still more important, the child did learn to suck, and the cleft approximated. If a record of models were kept it could be seen that in the first three months, in spite of no operation on the lip, the cleft would approximate according to the amount of work which the child did. For that reason when a practitioner made his plate he should make allowance for the cleft to approximate; otherwise if he put in a plate and carried it right up in the cleft, the approximation of the cleft would probably be hindered. That had been brought to his notice after having made a plate for a very small child, and he had been astounded that the child had broken the plate; he had not been able to see how it could break a piece of hard vulcanite. He took another model, and it had then become obvious that the cleft had approximated. Therefore he always now relieved heavily in the cleft in order to allow the two parts of the maxilla to approximate. If a child had a hare lip or a double hare lip the plate had to be carried up into the cleft, and again the value of the plate in such cases was that the child could feed. As to the breast, it depended largely on the amount of milk supplied. If there was not much milk, the child would not be able to get it; but if there was a fair supply of milk there was no difficulty. Another value of the plate was that the operation on the hare lip was not quite so necessary; it need not be done so soon, and if the practitioner could wait for three months the cleft would approximate, and there would be more tissue available, and the plastic surgeon could more easily operate. If any member desired to see the plate personally he would be pleased to show it. He did not always carry it quite so far back into the nasal pharynx as Mr. Highton had shown. He did not carry it back as far until the patient was about 3 or 4 years old.

Mr. Highton thanked Mr. Pitts and Mr. Fry for their valuable suggestions. He had had the same experience himself as Mr. Fry had had with regard to taking the impression. He had found the child had quite easily taken in the tray, and once the tray was in position it had sucked vigorously, and had not troubled about it being there at all. He had been very pleased to hear the ideas of Mr. Fry on the matter, as the case was quite an experimental one on his own part, and he had had no previous experience of cleft palate cases.

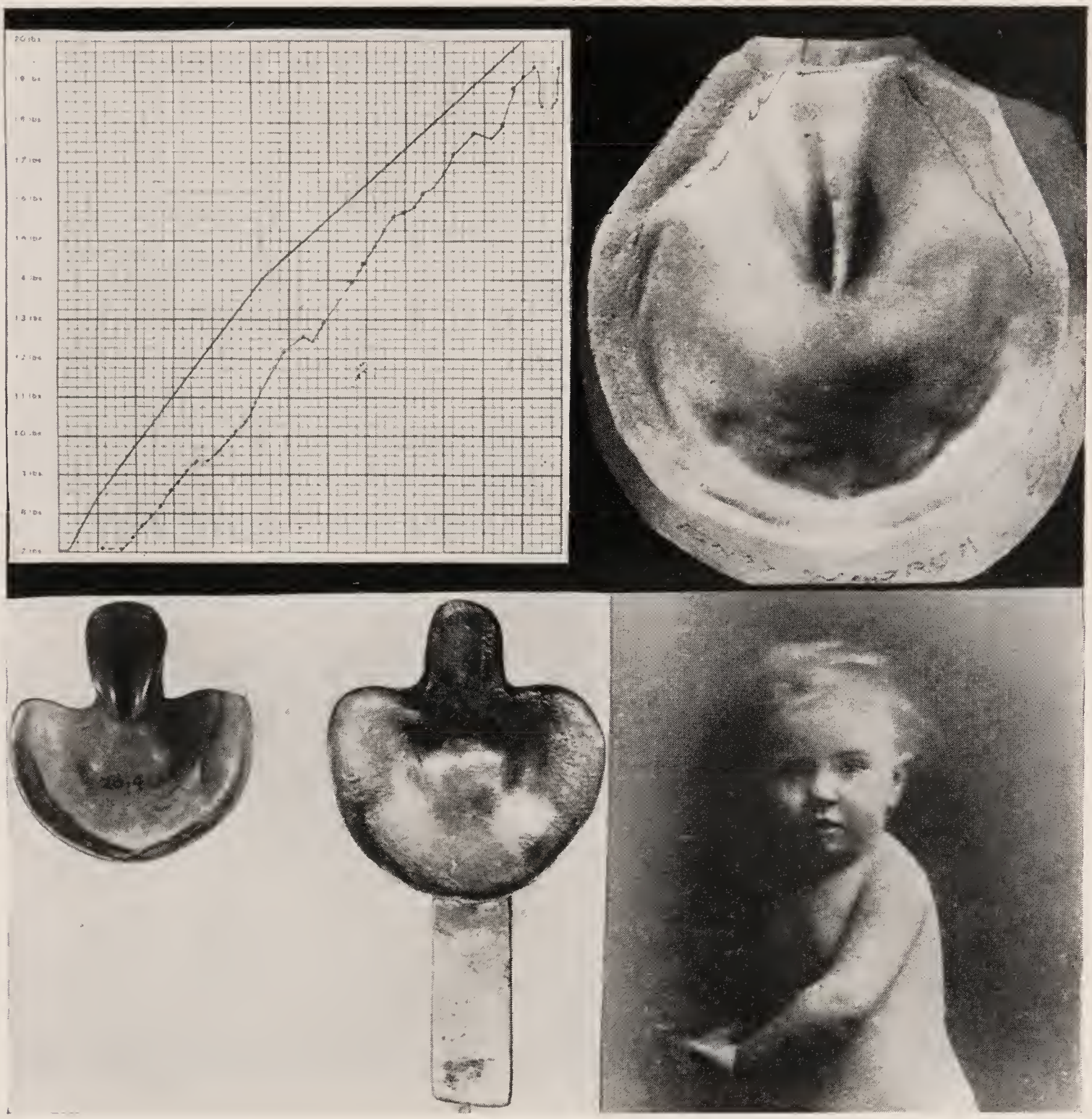
TWO CASES OF ANGLE'S CLASS 2 IN THE SAME FAMILY.*

By W. A. Bulleid, L.D.S.

Mr. Bulleid said he was afraid that the case was an extremely trivial one, but he brought it forward in the hope that it would be a sort of peg on which to hang a short discussion. The only point of interest in the case lay in the degree of deformity and in the similarity. The children were brother and sister. When he had first seen them the boy had been 12 years old and the girl 10. Seeing that they were two children of the same family and so

* *Transactions*, Jan. 18th, 1926.

A CLEFT PALATE CASE.



ILLUSTRATING MR. HIGHTON'S COMMUNICATION.

TWO CASES OF ANGLE'S CLASS 2 IN THE SAME FAMILY.

ILLUSTRATING MR. BULLEID'S COMMUNICATION.

near to the same age, he thought it was a reasonable inference that, whatever influences were at work producing the deformities, they must be the same. The members would see from the photograph that the appearance of the children was really very hideous. He did not often speculate as to the etiology of cases. There was nothing remarkable in the history at all. They were well-developed children for their age. There was no history of rickets. Both children were full term, both were breast fed, and neither had had any child illnesses nor adenoids. He had wondered if there was an hereditary factor involved. He had questioned the mother and father, who were themselves quite normal, on that point, but they did not know of any members of the family who had shown any such deformity. There had been nothing abnormal about the children's temporary dentition. He thought any hereditary factor could be definitely excluded.

He had come to the conclusion—and it was on that that he wished some enlightenment from the members—that whatever factor had produced the deformities was of a local nature. There was nothing abnormal about the children at all except their jaws.

What had made him think that the condition was purely local and not very deep-seated, was the ease with which the deformities had been corrected. The girl had got perfectly normal in eight months, and the boy had taken rather longer. If there had been any hereditary factor, he did not see how the correction could have taken place so quickly. As there had been no tendency whatever to relapse, he was inclined to think that some obscure force was acting locally.

(Mr. Bulleid then showed a photograph and models of the cases.)

Discussion.

The President thought the cases were extremely interesting, but it would take an immense amount of time to go into their etiology.

Mr. Bulleid thought there was something perfectly local in connection with the case.

The President said they were not marked in their occlusion. It was rather difficult to understand whether they were both bilateral.

Mr. Bulleid said it was almost bilateral, as a matter of fact.

The President asked if, upon the eruption of the permanent canines, they had erupted very much wider than the temporary canines which, on a casual glance, might have given a backward action on the mandible.

Mr. Bulleid replied that when he had started treatment the canines had erupted. In the boy the deformity was more advanced. He was two years older. They were exactly the same, except that in the boy it was slightly more advanced. They were absolutely bilateral.

Mr. Northcroft inquired if Mr. Bulleid had models of the completed case, and also if Mr. Bulleid would be good enough to show the models of the case in about a year-and-a-half or two years from now. He thought it was so fortunate that the case had been completed so rapidly and remained in such good position and that it would be most interesting to place the models in the museum after a lapse of time.

Mr. Bulleid said he had the models and would hand them round.

Mr. Marsh asked if Mr. Bulleid could say anything about the condition of the nasal passages in the children. As far as he could see from the rather badly illuminated photograph, the boy had quite nice wide nostrils, but he would like to know if an investigation had been made on the condition of the children's nasal septa.

Mr. BULLEID said so far as he knew the nose and throat had not been examined by a specialist, but the mother had assured him—and he had seen no evidence to the contrary—that both children were nose-breathers and neither of them had ever had adenoid growths removed. Their tonsils were not particularly enlarged, and the throats on the whole were perfectly healthy.

Mr. CHAPMAN said the model which he was about to exhibit illustrated the case which he had desired to show in connection with Mr. Stedman's paper at the last meeting. It was a case which it was decided to treat by extraction. (Mr. Chapman then exhibited the model.) He had merely brought the case forward to show that the extraction method was extremely simple sometimes, but that unfortunately it did not always work in the way in which it was desired or expected to. In this instance a lower central was removed to permit the instanding lateral to come into place, there being more than enough room for it. However, instead of this happening, the space closed in the course of one year so that instead of there being ample room for the lateral it was definitely shut out from the arch.

The PRESIDENT said the members were very much indebted to Mr. Chapman for bringing the case forward. It displayed a great amount of courage, and the Society was very grateful to him.

Mr. MAXWELL STEPHENS said no doubt many of the members could bring forward similar cases. He could remember two of his own, from which he had learned that if one removed lateral incisors in such a position, it was very necessary to maintain the width of the arch, because there was a flanking of the arch on that side, and apparently the canine and premolars moved inwards; and that was where the space was taken up.

Mr. PACKHAM asked Mr. Bulleid what treatment the children had had in the way of apparatus.

Mr. BULLEID replied that he had used the Angle ribbon arch. He had banded the four lower incisors, and had used ligatures on the bicuspid. He had used expansion on both arches and maxillary traction, and a depressing force on the lower incisors. There was nothing very creditable in it. The apparatus had been put on the girl in August; he had seen her eight times, and on the ninth he had taken it off.

Mr. PACKHAM said he had found, during his short experience, that such cases were extremely difficult to treat, and he congratulated Mr. Bulleid very heartily on his successful result.

Mr. BULLEID said the cases had responded so easily that he had been driven to the conclusion that it was purely a local condition.

Mr. PACKHAM then brought forward a case showing non-development of teeth. It was interesting, and so far as he knew, distinctly uncommon in the respect that the members would see that on the left side in the maxilla the canine was absent, and on the right side the first premolar. Symmetrical non-development of teeth was anything but rare, but so far he had not seen a case of assymmetrical non-development of teeth. (Mr. Packham then proceeded to show slides of the case.) The child was post-normal, and some years ago treatment had been started by capping the temporary teeth and bringing the lower jaw forward, allowing the first molars to over-erupt. He had noted that, after she had worn the plate for several months, satisfactory progress was being made. The first molars were over-erupting, and opening the bite nicely. The first deciduous molars however seemed to be bitten into the gum. That point was illustrated very well on the model, where it could be seen that they were almost covered by the gum. It was the assymmetrical non-development of the two teeth that he wished to bring to the notice of the Society that evening.

Mr. MAXWELL STEPHENS said he had been examining the photograph of Mr. Bulleid's case, and he would like to ask if Mr. Bulleid had a photograph of the completed cases, because it was frequently

the fact that a girl and a boy, in their heights and type of face, were different. Sometimes one had an oval face, and the other had a square type of face. The cases under discussion had both been expanded by the same method, and it would be extremely interesting, as they grew, to observe the types. There might be more teeth visible in the girl, who had an expanded arch, if she had an oval type of face, whereas in the boy it might be perfectly natural.

Mr. BULLEID said as far as the shape of the face was concerned, the boy's was far more massive in every way than the girl's. It was a very broad, square face. The girl had a more oval type of face. The boy showed the teeth more than the girl, but neither of them to any abnormal extent.

Mr. H. CHAPMAN said he presumed from what Mr. Bulleid had said that the assumption was that the cases were originally normal until a certain time. If the irregularity was due to a local cause, apparently the arches must have been normal before that local cause had come into operation. It seemed to him that until someone showed such a case before it had become abnormal and after it was abnormal, too much reliance could not be placed upon that—not that he had any reason to doubt what Mr. Bulleid had said, but he did not think there was sufficient evidence. He could not conceive how a normal occlusion could possibly get into the condition that either of the cases shown had got into, and it seemed to him then that the case must be ante-natal. Whether hereditary or not it was more difficult to say. The children looked to be of good general physique. He had tried to show in his paper at the corresponding meeting last year that it was more than likely that such children did not really have good physique—and when he said that he referred to the time of birth, because he believed that those children could become practically normal as regarded their physical development as they grew up. One frequently saw boys and girls who were really fine specimens of childhood and yet had teeth which were a great disfigurement to them. Therefore it was quite possible that the children under discussion might have had much weaker physiques at the time of birth and in the first years of life than they had at present. One had to go very carefully into the history of such cases to discover that. He did not know whether Mr. Bulleid had gone into those minute details, but he thought if he did it was possible he might discover something. In one case, which he had shown at another meeting, he had personally found that the boy had very thin finger nails, among other defects, which showed that his physical condition was not good, although if one saw the boy one could hardly say that he was worse than his brother, who had a normal occlusion and a better history. Another point which he had noticed from the photographs was that the upper lip was rather short and curved up, exposing the central incisors, and that the lower lip was well behind those teeth. It seemed to him in such cases that whilst the children were probably nasal breathers at the time, they were not immune from mouth breathing at the same time, or anyhow during a portion of the twenty-four hours. He did not look on that as a factor, but rather that the mouth breathing was a result of the position of the teeth. Therefore he thought it was most important, if one was going into the etiology of the cases, to examine very carefully the earlier history, and not only the history of a year or two before the cases were seen.

Mr. PACKHAM suggested that he should send to Mr. Bulleid the forms which were got up in considerable detail, and ask him to fill them in. As Mr. Chapman had just said, the detailed early history of the cases would be intensely interesting.

The PRESIDENT said if Mr. Bulleid did attempt to fill up the forms he would like him to put in the fact as to whether or not there had been any symptoms of anæmia in the children at any time.

Mr. BULLEID thanked Mr. Chapman very much for his remarks,

which were just the sort of remarks he had hoped the Communication would bring forward. He had started out by speculating on the etiology of the cases, and he was speculating still. As a matter of fact he had applied for much more elaborate details of the early childhood of the children, but unfortunately the mother had had to undergo a serious operation, so he had not been able to obtain all the details for presentation before the members that night. The mother was a very intelligent woman, and he had not been able to get out of her anything as to any ill-health of the children in their childhood. The point that had struck him most about the cases was the speed at which the girl's mouth had returned to normal. If it was a deep-seated developmental defect he failed to see how it had got well so quickly. He would gladly fill up any forms the Honorary Secretary might honour him with.

THE PRESERVATION OF THE TEMPORARY DENTITION.*

By L. F. Fouraker, L.D.S.

I wish to draw your attention to some of the conditions we meet with in the temporary dentition, and to put forward some suggestions which may be helpful in preserving these teeth.

I have the opportunity of examining some three hundred children every month in the elementary schools, and the condition of the mouths of some of the children gives me plenty of food for reflection.

About one-third of the children have healthy mouths, but even they do not very often have a complete and efficient masticatory apparatus; too many of them have the temporary molars missing through premature extraction, due, in practically every case, to caries.

I think that much could be done by the dental profession if they laid emphasis on this needless extraction of teeth, because I am sure that a great many of them could be saved if the school dental surgeons were given better facilities for doing so.

This practice of almost wholesale extraction at the present time is certain to bring with it more trouble for the children as they grow up.

We see every day cases of malocclusion which almost drive us to despair, simply because the temporary teeth were prematurely extracted, and we are forced to do more extractions in order to put the child's mouth in a reasonable state of efficiency and appearance.

Many of these children will grow up and not take much care over their teeth, and as a natural result of the present policy, very many of them will have permanent dentitions which will be a happy hunting ground for gingivitis, caries and pyorrhœa, due solely in a great many instances to irregularities of the teeth, and we shall continue in the vicious circle of more extractions and the fitting of dentures.

How are we going to try and put a stop to this wastage of teeth and injury to health?

* *Transactions*, Feb. 1st, 1926.

(1) We should endeavour by every means to get into the closest co-operation with the proper authorities, and the teachers in charge of the children. They are the first persons who must be interested ; secondly the children themselves and their parents, because without the consent of the authorities and teachers we cannot get at the children. The practical part of the work should be to save as many teeth as possible, and condemn to the forceps as few as possible.

(2) When the mouth has been put into good working order the child should be shown how to brush the teeth correctly, and definite written instructions pointing out the best way and time for this to be done should be given to the parents.

(3) To supplement the chairside talks, lectures should be given to the parents and also to the children, and I feel certain that by this means much could be done to show that caries can be avoided to a great extent by paying correct and regular attention to the hygiene of the mouth. At the same time stress should be laid on the advantages to be gained by a proper diet of coarse foods, raw fruits and vegetables ; also parents should be impressed with the importance of having a definite time for meals, and not allowing their children to eat at all times. These lectures should be given by men who understand their work thoroughly and are in sympathy with it ; much better results would come if they could be given in conjunction with lantern slides to illustrate the various points. The use of lantern slides is, I think, very important, because it would help to give people a better idea of what a clean, healthy mouth looks like.

(4) Propaganda. I think that the dental profession has sadly neglected this type of teaching, and I think we are missing a tremendous opportunity of disseminating sound advice to the nation at large by not going in for it.

Dentists number some 16,000, and the population of the country is round about 48,000,000. How can we reach all these people except by articles in the papers ? Criticism of this would be that it would amount to advertising if the writer of the article had his name at the end of the article. Why not select a small committee (two or three) to carry out this work ? Articles could be written by the right men, who would receive a suitable fee for the work, and the articles published under the auspices of the committee, and if it was pointed out at the start of the campaign that this committee was the mouthpiece of the dental profession, I am sure that we should soon begin to see some results for the better in the state of the teeth of the nation as a whole.

Finally, as a young member of the profession, I feel that we are not doing all we can to teach the people the value of sound teeth and healthy mouths ; and to obtain this result, we must show the people by our own work, by lectures to all, and by propaganda carried out on sound and broad principles, how much they stand to benefit by attention to their teeth.

Discussion.

Mr. Rt. Lindsay said Mr. Fouraker had been dealing with a subject which he had always felt to be a real source of interest to such a Society, i.e. preventive orthodontics. He was sure it would interest Mr.

Fouraker to know that there was at the present moment in existence such a committee as that to which he had referred. The Dental Board of the United Kingdom was spending money at the rate of £5,000 per annum in order to promote propaganda in oral hygiene. One of the most important aspects of that propaganda was the means whereby expectant and nursing mothers, and through them, their children, might be made better dentally. The campaign embraced all the matters upon which Mr. Fouraker had remarked. He was certain that the results, in the comparatively near future, would be beneficial for the nation at large. It was also interesting to know that the British Dental Association had a Committee at present investigating the question of orthodontic treatment for elementary school-children; a distinguished member of the Society for the Study of Orthodontics was the Chairman of that Committee. He recalled an experience which he feared might horrify the members present; he had visited a school clinic, and had asked one or two questions as to the work done. The dentist in charge said it was his routine practice to extract temporary teeth. He (Mr. Lindsay) was hoping to visit that town and look at those children later when they were grown up, with a view to observe the results. He was assured that this practice had been carried on for some time, and that, when the children came back later for treatment of their permanent teeth, it had not been noticed that the treatment had any bad effects. That might appear to be an extraordinary statement, but it occurred to him (the speaker) that there might be something in it; that, if one extracted freely temporary teeth, not simply one or two, there might possibly be less harm than was commonly supposed. He desired to thank Mr. Fouraker for dealing with such an interesting and important subject; one which he was sure was going to be of very practical interest to the country in the near future.

The PRESIDENT said he was sure the meeting would be pleased to hear the opinions of some of the younger men who might be occupying the position of school dentist.

Mr. RIDDETT said he was possibly in a position to say one or two words on this matter as he had spent very many hours of chairside working on school-children. He felt that nobody who had not done this work was in a position to criticise or to know the exact state of affairs which confronted the dentist when he did this work. He would like those present to imagine what happened when a dentist began his session of 2½ hours. In that short space of time he would have to treat at least ten, possibly twelve, and sometimes fourteen children. He did not say there was a great deal for each child, but that number of children had to pass through his hands, and he had to deal with them thoroughly in order that in future sessions his work should not be overwhelmed with reappointment cases, i.e. children who had not been cleared up at that session. In the schools 33 per cent. or possibly more of the children were in need of treatment. As everybody knew, during school years caries were very rampant; in many cases children came up for treatment with seven or eight carious molars. The dentist was faced with the problem of what to do; almost invariably he was compelled to put such a child under an anæsthetic and have the teeth cleared out. That was a simple case; where one found septic teeth one could not do otherwise than extract them. He had hoped to hear a little more from Mr. Fouraker as to what he would do in a case where the upper or lower secondary deciduous molars were in such a condition that it was impossible to fill them satisfactorily. He believed it was the practice of some dentists to clear out those teeth when they were infected and the pulps were dead, so that the secondary molars should not give trouble with regard to malocclusion, with which it was difficult to deal. After six years' experience of such work in the course of which he had examined perhaps 30,000 children, he found that it was possible to pick out children who had had these wholesale

extractions, and in many cases it was found to be best to clear out those teeth. He was not prepared to say that when those children reached the age of 15 or 16 years, that problems might not arise owing to the crowding of the premolars; but nature appeared to look after those cases in an extraordinary way, and very often when children had crowding of premolars it was not a difficult matter to treat those cases by extraction. The school clinic dentists were faced with an enormous problem. When he personally first took on this work he was told that he had to get through it and do the greatest good for the greatest number. It was, of course, impossible to give ideal treatment under such circumstances. All one could do was to try to find out the best way. Mr. Lindsay's remark as to the practice of the dentist at the clinic had caused him to speak because he thought Mr. Lindsay must be under a misapprehension; he could not imagine any dentist undertaking this work extracting the whole of the eight temporary molars as a routine treatment. He thought that what probably happened was that when that dentist was faced with say four or five diseased and hopelessly disorganised teeth, he might extract the opposing healthy teeth; that was called symmetrical extraction. He felt it would be regrettable if at a meeting of this sort it was thought that any dentist in his senses would act in the way that Mr. Lindsay had suggested.

Mr. LINDSAY said that speaking rather rapidly he had perhaps given rather a wrong impression. The dentist extracted all decayed teeth and cleared out all decayed temporary teeth and was quite sceptical as to any bad results coming from the practice. He did not criticise the action of the dentist, but was interested to know whether the treatment had the good results claimed for it.

The PRESIDENT asked if there had been any effort to fill teeth.

Mr. LINDSAY said no, not decayed temporary teeth.

Mr. B. SAMUEL said he unfortunately could not claim to be one of the younger members, but he could claim to have done some of the very earliest work in London on elementary school-children. He thought Mr. Fouraker was perhaps a little too pessimistic. He personally saw a great number of children, and had been seeing a great number of children thirteen years ago; he thought there was a great improvement in the condition of children nowadays; one did not experience the same appalling conditions of general decay, and his impression was that there was not the same percentage of bad teeth. He put that fact down largely to the effect of propaganda work. A certain amount of propaganda work had been done indirectly during the war by soldiers receiving dental treatment and passing it on, speaking of the benefits of that treatment in their homes. He did not know whether it was the general opinion, but his impression was that one experienced less very bad cases among elementary school-children than hitherto.

Mr. A. T. PITTS said that when a dentist attended children he obviously had to look ahead to the future. He must keep in mind two points of view; one was that if temporary teeth were lost before their time almost certainly there would be crowding of the premolars; the second point of view was that by leaving septic teeth in the mouth one was running a very great risk of injuring the nutrition of the growing child. If one kept in mind exclusively one or the other point of view and did not endeavour to reconcile them both in some degree, he believed one was making a mistake. Occasionally doctors wandered down to his department in Great Ormond Street. He had pointed out to one of these doctors the other day that in the cases of many of these children it was necessary to extract freely; this would lead to crowding, but crowding was a minor evil as compared with sepsis. The doctor had said that he was interested to hear that, coming as he did from one of the Colonies, because it was a common experience there to find dentists refusing to take out temporary septic teeth,

because they said it would spoil the arrangement of the secondary teeth. He (the speaker) had seen a lady that morning who had told him that her child had for over a year had four or five septic teeth with sinuses, but the dentist refused to extract, and, in fact, only did so when great pressure was brought to bear on him by the family doctor. That case indicated the evil resulting from one point of view, while the dentist of whom Mr. Lindsay spoke was an example of the evil of the other point of view. He found that there was much less crowding of the temporary dentition if one did not do symmetrical extraction. He thought the practice of symmetrical extraction was a fallacy. Another factor which in his opinion led to unnecessary extraction was the practice of making a diagnosis straight away as to which teeth could be saved and which could not. When one looked into the mouth of a child with caries, one saw that there were some teeth which had to come out, but that there were others which could be saved, while others might be uncertain. His practice was, if the child was not suffering pain, to start with all those doubtful teeth; if on opening them up he found they were septic or with exposed pulps, he held the opinion that it was better to extract them. Then when he had finished all his fillings he was then left with teeth which had to be removed. If that procedure was adopted it was usually found that the number of teeth which had to be removed was smaller. There was also the great advantage of leaving the extractions under an anæsthetic to the end, so that the child's confidence was not destroyed at the beginning of the treatment.

Mr. Packham said it occurred to him that if the temporary teeth were all removed the massaging effect which was produced by mastication upon the developing permanent teeth below them was absent and might have a definitely harmful effect. He did not know whether anybody had done any experiments in that direction, but it occurred to him to wonder whether the calcification of the permanent teeth (if they were no longer massaged by the mastication of the deciduous teeth in front of them) was impaired, and whether such teeth were more likely to become the victims of caries.

The meeting concluded with a vote of thanks to the speakers.

A NOTE ON PERCUSSION AS A STIMULUS TO THE GROWTH OF BONE.*

By Mrs. Lindsay, L.D.S.

In the discussion following the paper in which Dr. Quintero described his ingenious method for dealing with incisors which were in faulty alignment, or which had lost the incisive edge through accident, and in consequence were not on a level with their neighbours, the question arose as to the liability of those teeth to return to their former position, and Dr. Quintero was questioned as to means whereby this danger of relapse might be obviated.

In conversation with Dr. Quintero after the meeting I suggested that percussion of the alveolus over the apex of the moved tooth might have the effect of stimulating new growth of bone in the socket, thus consolidating the position and rendering secure the result obtained.

This was not a haphazard suggestion, but was founded on a limited personal experience of the benefit of percussion in certain cases in practice; it was also supported by the record of a large

* *Transactions*, Feb. 1st, 1926.

number of clinical cases reported by H. O. Thomas, the surgeon, whose name is associated with the Thomas splint, and who was one of the most experienced of the early orthopædic surgeons.

In a series of papers written by him in 1886 on the treatment of "Fractures and Dislocations," Thomas describes his treatment of cases of delayed repair and union of fractured bones by flagellating the surface over the seat of disunion with a copper-headed hammer padded with rubber.

Some of the ununited fractures thus treated were of long standing and had been previously treated by all the known methods, including wiring, rubbing the broken ends together, resection, etc. All attempts to effect union by these means had failed, yet success was attained when percussion was well and truly applied.

The case which, it appeared to me, bore most upon the present interest was that of a young girl whose patellæ slipped over the condyles of the femur, despite the fact that strong leather caps, firmly strapped, were employed to hold them in position.

Thomas hammered the surface over the condyles with moderate percussion every week for five months for the left patella, and during nine months for the right, and by this treatment alone induced a ridge of bone to form on each condyle, thus making it impossible for the tendons to slip. Recent studies in the growth of bone have shown that one of the most effective stimuli to growth is intermittent pressure.

When I was in practice, after finishing the movement in a regulation case, it was my custom during the retention period to employ what I called "vibrant massage." This was carried out by means of the automatic gold plugging mallet used in the electric engine, with the largest plugging point padded with the india-rubber cork of a novocain tube. I was employing Thomas's percussion method without knowing it.

This proceeding I found efficacious as an aid in the treatment of teeth loosened by any inflammatory process such as stomatitis, pyorrhœa, etc. We may recall, in this connection, those cases not infrequently reported in dental journals, of the ultimate eruption of wisdom teeth or of canines in patients of advanced age, following on the insertion of artificial dentures.

I would suggest that this may be accounted for by the intermittent pressure consequent on mastication, stimulating growth of the alveolus and thus bringing about the eruption of the tooth. I had, for example, a girl of fourteen years of age brought to me for whom an unregistered practitioner had extracted a temporary canine, and had thereafter inserted a plate bearing a single tooth, telling the mother of the girl that there was no permanent tooth present. The pressure of the plate acting on the alveolar bone stimulated renewed growth, which ultimately brought the retarded permanent canine into position.

I would suggest, therefore, that the method employed by H. O. Thomas, modified to suit dental conditions, might be employed with advantage to bring about certain orthodontic results such as :

(1) Stimulating growth of alveolar bone around the roots of teeth which have been moved for purposes of regulation, and particularly in those cases in which an upper incisor has been brought down into alignment.

(2) Hastening the eruption of retarded teeth, and generally for treatment of a stimulant and tonic nature applied to the gums in connection with orthodontic and other dental conditions. The method of applying this system of " vibratory massage " and of percussion can of course be varied in accordance with the ingenuity of the operator ; an eccentric rotating point in the ordinary hand-piece would produce the same effect.

If this communication seems trivial it has at least not taken up much time, and the fact that it has been submitted at all may be taken as an indication of the keenness of the Hon. Secretary as a snapper up of unconsidered trifles.

Discussion.

The President said he thought Mrs. Lindsay's " unconsidered trifle " opened up a very wide field for discussion.

Mr. Livingstone asked whether Mrs. Lindsay invariably applied vibratory massage to the gums over the diseased alveoli in cases of pyorrhœa, and also whether she had tried the effect of vibratory massage on the crowns of temporary teeth that had been retained beyond the normal shedding period with a view to stimulating the succeeding teeth.

The President asked whether Mr. Sturridge, in his crusade for ionic treatment for pyorrhœa, had not insisted as an after treatment to the actual ionisation that there should be massage with vibratory rubber.

Mrs. Lindsay said " Yes."

The President said he himself had used that method to a great extent, until his apparatus had broken down.

Mrs. Lindsay, replying to Mr. Livingstone, said she would wait until she had treated the gums first ; when the gums were restored as far as they could be restored to health, then she would use the massage. She would not percuss over the crown of the temporary teeth retained, but over the alveolar process over the gums. She had not tried it.

Mr. A. L. Packham read a short communication on " A Case showing Tooth Movement." He showed models of the teeth of a girl of 16, the right central incisor tooth of which had been extracted at the age of 12. The space had now completely filled up. The occlusion on the left side was normal. The occlusion on the right was apparently post-normal. This was not true post-normality, being due to the left maxillary teeth moving forward.

Mr. Badcock said he had a similar case where a right upper incisor projected very considerably. For reasons which he did not think it necessary to go into, he extracted that tooth. No other treatment had been undertaken. The boy was now grown up, and his right lateral was now touching his left central, giving an effect precisely similar to that shown by Mr. Packham. He (the speaker) had seen the boy recently, and had asked him whether he thought people had ever noticed that he had lost a front tooth ; and the boy had replied that he did not believe anybody ever did notice it. In this case the lower jaw had its proper complement of teeth, and being post-normal the extraction of this particular tooth had allowed the upper teeth to come back and lie against the lower teeth as they should do. He thought it was encouraging to know that such a good result could be obtained in so simple a manner, because there were many cases where ordinary regulation was out of the question and where such treatment might be adopted.

Mr. Packham, in reply to a question, said the central incisor in his particular case had been extracted at the age of 12, the girl being now 16.

Mr. McMahon said he had dealt with a case in which the girl lost the upper central through falling in a ballroom. In that case nothing had been done ; it presented a very unsightly appearance, although the gap had closed up. The accident happened at the age of 9.

Mr. J. H. Badcock said the case of missing upper laterals was rather analogous. In many such cases he had found that, if one extracted a lower tooth, it allowed the upper teeth to fall back and together until the canines touched the centrals, and the result was often very good. Sometimes one had to go a little further and extract two lower incisors. In a case where this was done the gap had closed up perfectly, the child having quite a presentable appearance, except that the arch of the mouth was a little flat in front. It seemed to him that this was far better treatment than endeavouring to fill gaps. To inflict on a young patient any mechanical device which could possibly be avoided, or anything in the way of artificial teeth was the greatest possible mistake, if one could find any other way of dealing with the case.

THE CHOICE OF ORTHODONTIC APPARATUS IN THE MORE COMMON FORMS OF MALOCCLUSION.*

By H. R. Evans, L.D.S.

I feel that first of all I ought perhaps to apologise to you, because I fear that you will find very little, if anything, which can be regarded as original in this short paper, and I am afraid that most of it will be of an extremely elementary nature. Unfortunately, owing to force of circumstances, I was not able to devote much time to preparation, and this, together with the difficulty of obtaining suitable data at short notice, has handicapped me considerably. Again, I think that most of you will appreciate the fact that to stand up before such a distinguished audience as I have this evening, and to try and interest them even for a short while, is by no means an easy task. However, there are perhaps present one or two very junior members, who may find something of interest in my remarks, and profit by them. If such is the case, perhaps I may not have entirely failed.

When confronted with the problem of choosing the type of appliance to be used in a case of malocclusion, there are certain definite principles which we always endeavour to embody in the construction of the apparatus, and in describing the attributes of an ideal appliance I think that I can do no better than quote the words used by Mr. J. W. Mayer in his paper on "Torsion: Some Facts and Probabilities," read before this Society in October, 1924. Mr. Mayer said: "My ideal apparatus would be comfortable, hygienic, easy to construct and adjust; the force exerted by it would be gentle, and yet continuous, there would be no possibility of applying too great a force in adjustment—a very important provision, for we are sometimes in a hurry, and inclined to overdo things—each adjustment should be definitely measurable in some way." These remarks, I think, sum up admirably the points which should be borne in mind when constructing an appliance. In the first place, if due regard is not paid to comfort, the appliance, if removable, will spend most of its time in the patient's pocket. Simplicity in construction and adjustment should be the keynote. A complicated appliance instead of carrying out the necessary work very often produces movements which were never intended. We have long learnt the wisdom of using forces which are slow

* *Transactions*, Feb. 1st, 1927.

and continuous in their action. We are told that the inevitable result of prolonged and extensive orthodontic treatment is the dread periodontal disease. Such is undoubtedly the case if teeth are moved too quickly ; the growth of bone is also adversely affected, and the difficulty of retention greatly increased. Intermittent forces undoubtedly do not usually bring about ideal results. Hygiene is of course a very important factor, our work is of no avail if gingival irritation and its sequelæ are caused through lack of cleanliness. If we can so construct our appliance as to avoid applying too great a force in adjustment, then we have indeed accomplished something of great value to ourselves. Our adjustments can then be made with confidence, and without the loss of much time, which is of priceless value to the dental surgeon.

Now, I do not propose in this short communication to discuss in detail the relative advantages and disadvantages of fixed and removable appliances, but perhaps a few general remarks will not be out of place. For my own part, I have always tried to keep a perfectly open mind on this subject, and when deciding on the type of appliance for a given case, I choose the one which I consider will carry out the work in the most efficient manner, whether it be fixed or removable. At the same time I must confess to a partiality for removable appliances. If I consider that a plate will give me as good a result as any other appliance, I always choose the plate. I cannot help thinking that something which can be taken out of the mouth, and cleansed at intervals, has a distinct advantage, at any rate from a hygienic point of view, over an apparatus which is a fixture, and which surely must be very difficult, if not well nigh impossible, to keep ideally clean. Some authorities base their objections to appliances such as the labial and lingual arches on the assumption that direct injury is caused to the periodontal membrane by the placing of anchor bands on the teeth. This in my experience is a debatable point, as it does not seem to me at all necessary to force the band right up under the gum in order to obtain adequate retention. The main object of cementing the band, I regard as a prophylactic measure which prevents the access of food debris and fluids to the tooth surface, thus avoiding decalcification of the enamel, although at the same time it does assist in retaining the band to the tooth. I *have* noticed, however, when patients wearing fixed appliances have presented themselves for inspection, that as a general rule quite an appreciable amount of food debris has collected around the bands, and it is here I think where the chief danger lies. Frequently the gum around the tooth becomes inflamed, and very often this inflammation tends to spread to the adjacent teeth. Whether the resistance of the patient is sufficient to allow of the complete recovery of the teeth in question, I am not in a position to state. I have not had the opportunity of examining teeth some years after the anchor bands have been removed, but I should welcome the views of members who have had a long and wide experience of these cases. One great drawback, I think, to fixed appliances is the fact that they necessitate very frequent visits to the dentist, and in the case of children at boarding school, this is of course impossible. In private, one's orthodontic practice may quite feasibly consist entirely of patients who are away from home for the greater part of the year, so that the use of fixed

THE CHOICE OF ORTHODONTIC APPARATUS IN THE MORE COMMON FORMS OF MALOCCLUSION.

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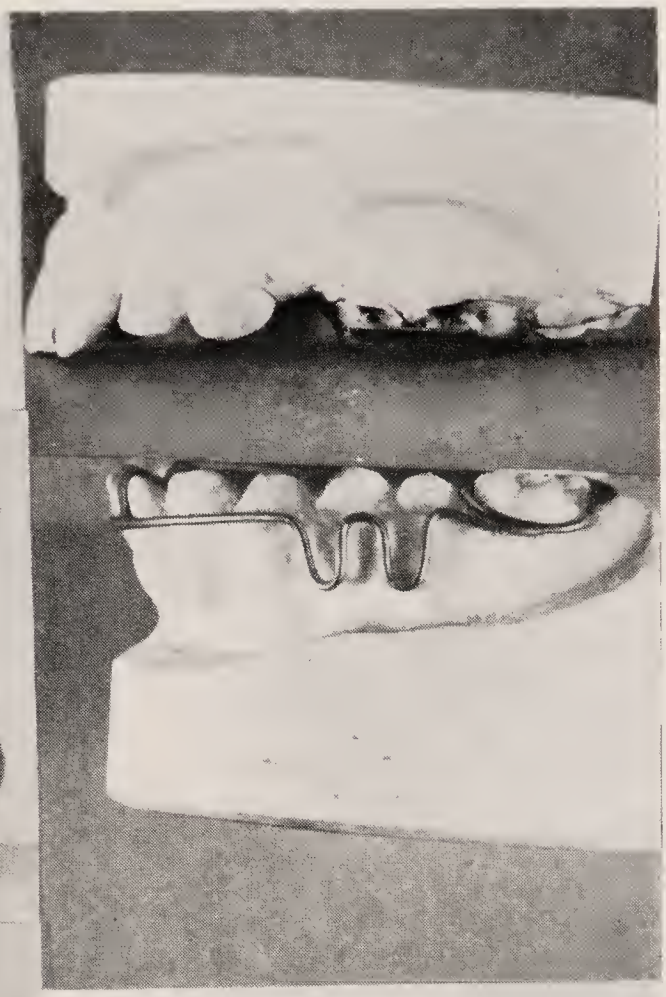

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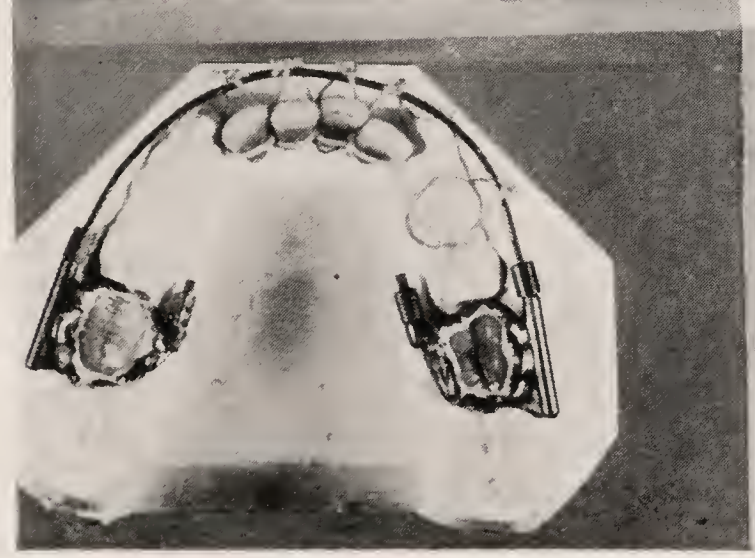

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ILLUSTRATING MR. EVANS' COMMUNICATION.

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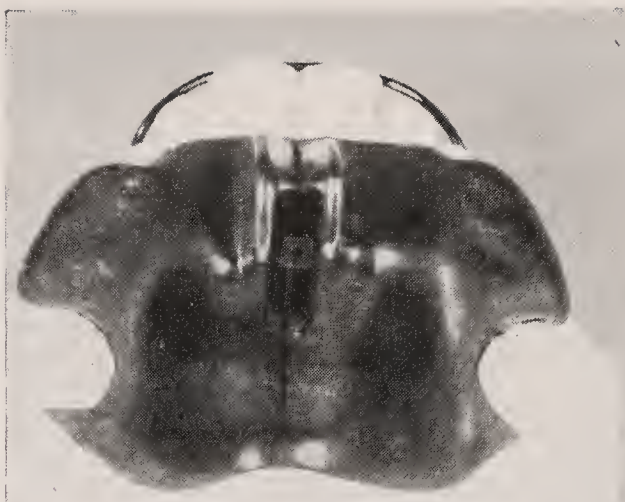

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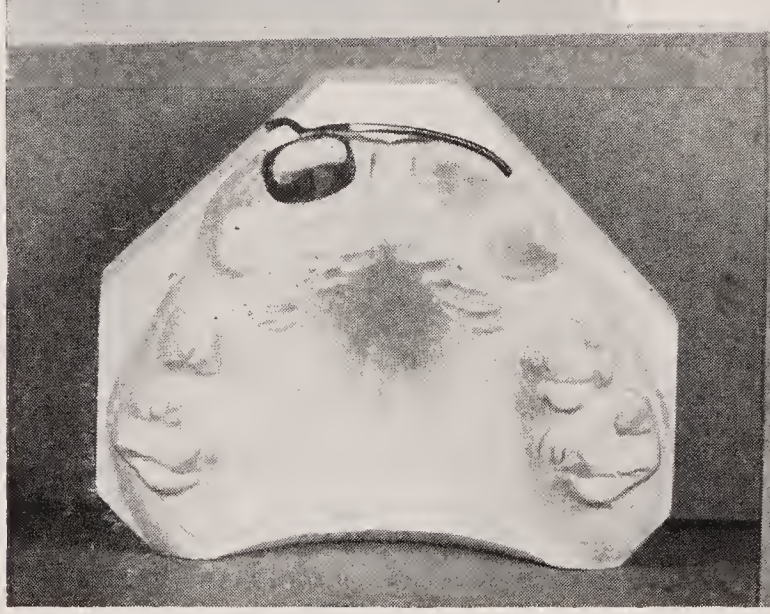

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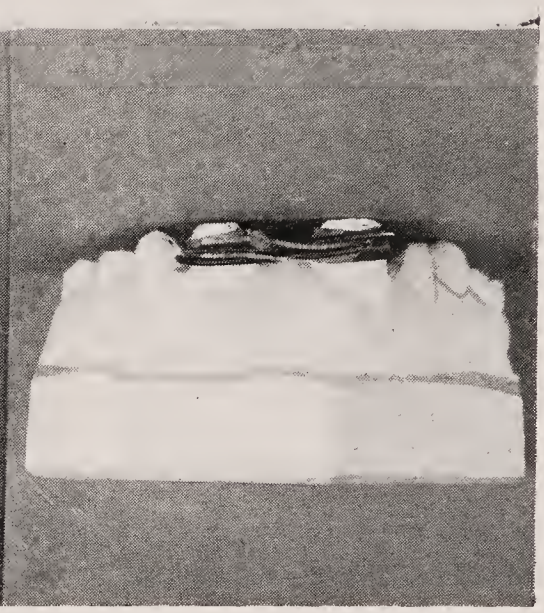


ILLUSTRATING MR. EVANS' COMMUNICATION.

appliances may be entirely out of the question. Fixed appliances, when manipulated by skilled hands, without a doubt carry out their work in a most efficient manner, and I think that most of you will agree with me when I say that they are in the main more efficient than removable appliances. They, however, can be most dangerous when not manipulated by a skilled operator, and for this reason perhaps it might conceivably be better for the general practitioner, who may not be in the habit of treating many cases of malocclusion in the course of his practice, to confine himself to appliances which do not require so much orthodontic knowledge and skill in their manipulation.

In the matter of retention and rigidity fixed appliances are superior to removable ones; this of course is a very important point, as in cases where accessory springs are being used, these cannot be expected to do their work properly if the appliance lacks rigidity. There is also the certainty that they are always being worn and not being inserted a few minutes before seen by the dentist. Perhaps some of the members will kindly give us their views on fixed and removable appliances at the close of my paper. It may be that my partiality to removable appliances is due to influence brought to bear during my youth. I can well remember during my student days, the surgeon of the day asking the class the type of appliance they would construct for a case under consideration. One poor misguided youth said that he would use a fixed appliance. Words fail me to describe the consternation which ensued. Let it alone be placed on record that the student in question was never afterwards seen at that particular clinic. However, since becoming a member of the British Society for the Study of Orthodontics, I am glad to say my general outlook has been considerably broadened, and I sincerely hope that its influence will continue to enlighten me on many problems which at present tend to keep me in a pessimistic mood.

It has occurred to me that in the case of the practitioner who does not have the opportunity of treating many cases of malocclusion it might perhaps be to his advantage to select some appliances applicable to the more common types of irregularities with which he meets in everyday practice, and thoroughly master their technique and adjustments, rather than that he should have a scanty and superficial knowledge of several types of appliances which he never has the opportunity of becoming familiar enough with in order to be really skilled in their manipulation. Of course I do not wish in any way to discourage those who are possessed of inventive genius, and who wish to experiment; my remarks are directed rather towards those who have not the time or perhaps the inclination to interest themselves in this subject.

It is now my intention to show you a few slides, illustrating some types of appliances which I have found in my short experience to answer the requirements very well, in some of the more common forms of malocclusion, which we meet in daily practice. I must aske you to excuse the lack of finish to the appliances, but as I have mentioned before, they had to be made at very short notice, and they are merely being shown to indicate the principles employed. Probably the first orthodontic case which the student has to treat, is one in which an incisor has to be brought over the

bite, and I am sorry to say that my experience is, unless you watch him very carefully, he shows an overwhelming desire to specialise in this type of malocclusion. I have always found vulcanite pegs inserted into a plate quite satisfactory in these cases. It is generally necessary to cap the back teeth; the peg should project sufficiently long so as to prevent the plate from going right home. The lower incisors then impinging on the plate will bite it home, thus forcing the incisor forward. The force transmitted is not continuous, but if the peg is not allowed to project too far the results obtained by regulating teeth in this manner are quite satisfactory. It is very important to arrange for the lower incisors to occlude with the plate. When the four upper incisors are inside the bite, it is very often necessary to build a platform projecting in the front, in order to allow the lower incisors to occlude.

The Retraction of Upper Incisors.

Figs. 1 and 2 show you the type of appliance I invariably use for the retraction of upper incisors. The back teeth are covered with a metal cap on the buccal surface of which is soldered a tube. The cap and tube are embedded in the vulcanite. The labial wire is attached to the plate by passing it through the tube, bending it back, and hooking it around itself in front of the tube. The great advantage of this is that in the event of its being broken, as so often happens, it can easily be replaced without loss of time. The metal cap which is struck up in Manhattan platinoid, gives added strength to the plate, and is not very easily bitten through. When only a thin cap is desired the metal is not covered with vulcanite, and is usually gilded. B size round gold wire is used for the labial wire. When using this type of plate in a case of superior protrusion, where the first premolars have been extracted, I find it seldom necessary to arrange for the retraction of the canines, prior to bringing back the incisors. The teeth come back very evenly by using the W spring. In cases where room is being made by expansion, pressure is automatically brought to bear on the incisors. I am fully aware that by capping the back teeth I invite criticism, but my experience is, that provided all the teeth are capped, no evil results will accrue. If however certain teeth are allowed to elongate an open bite will result. This is of course done deliberately when it is necessary to cure a deep overbite.

Fig. 3. This slide shows the photograph of a plate I have found very useful in cases where for some special reason it is not desirable to cap the teeth. It is more applicable of course to cases where the first premolars have been extracted. The force is exerted by a half round split gold wire.

Fig. 4. In cases where there is insufficient room to bring the wire between the teeth, I have sometimes used this type of plate. Retention is obtained by means of cribs on the molars, and the labial wire with W spring is soldered to the cribs. The cleats on the central incisors are of course to prevent the wire riding up the teeth. A certain amount of difficulty is experienced in keeping this plate in position, and I cannot say I have found it very successful.

The Expansion of the Arch.

Fig. 5. An old and trustworthy friend of the orthodontist is the Badcock screw, and I think you will agree that it is the best

design we have for expanding an arch with a divided plate. The screw and wire and sleeve impart rigidity to the plate. The two halves open parallel and are prevented from revolving on one another. The plate being rigid, finger springs can be attached to perform accessory movements. The screw, which is operated by a single nut, can be turned by the patient at stated intervals, and the expansion can go on without frequent visits being made to the dentist. In the improved type of screw, a spring tension device, which is housed within the winged hub, prevents the screw from working loose and being moved by the tongue, or turned when the plate is being cleansed.

The number of turns of the screw necessary to produce a certain amount of expansion can be easily calculated.

Advancing of Lower Incisors.

Fig. 6 shows a type of plate which can be used for advancing lower incisors. The force is exerted by the finger springs soldered to the lingual bar. It is advisable to fix to one or two of the incisors pinch bands, carrying a shoulder on the lingual aspect. This shoulder of metal prevents the finger springs from riding up the teeth. The cleats on the molars prevent the plate from sinking.

The most efficient method of treating this type of case to my mind is by means of a buccal arch (Fig. 7). The teeth are ligated to the arch by means of grass line ligature, which has the property of contracting under the influence of moisture. If a 19-gauge alignment arch be used, the springiness of the arch can be used in addition.

Treatment of Class 2 Cases.

In treating cases of inferior retrusion I find that the plate shown in Figs. 8 and 9 is most efficient. The Badcock screw for expanding the arch, the incline plane for guiding the lower jaw forward, and the labial wire for retracting the upper incisors are all combined in the one plate. The bite is raised by capping the premolars or deciduous molars as the case may be. The inclined plane is so arranged that the patient must of necessity close in the correct forward position. In order to ensure constructing the plane at the correct angle it is advisable to previously obtain the patient's bite in the forward position.

Torsion.

The most efficient appliance for the rotation of an incisor that I have up to the present come into contact with is the Korbitz appliance. Figs. 10 and 11 show this appliance in position. A pinch band of Blue Island metal is made to the tooth to be rotated. A tube is soldered to the pinch band on the buccal surface parallel and near to the outstanding border of the tooth. A rod, bent at right angles, is fitted into the tube, and adjusted so that it rests on two or three of the adjacent teeth. These teeth act as the resistance. A ligature, rubber or grass line, is stretched from the rod to a hook soldered to the lingual aspect of the tooth near the instanding border. The tooth is in this manner rotated in its own axis. I have found this method satisfactory for rotating premolars.

The Bringing together of Incisors.

I have for some time discarded plates for bringing incisors together, and am now in the habit of using pinch bands and ligatures. In cases where the teeth are widely separated my experience is that there is a tendency for the teeth to become rotated with their distal borders directed outwards, as shown in Fig. 12. By having a prolongation of the hooks, as shown in Figs. 13 and 14, however, I find that this fault is obviated. The teeth follow the path of the wires, and are thus prevented from rotating. I prefer to use grass line ligature, as its action is slow and continuous.

Those are all the appliances I have to show you, and I think that the majority of the more common malocclusions which we come across in daily practice can be successfully treated with them. I have made no mention of Angle's ribbon arch and the fashionable lingual arch. The former, although a beautiful piece of mechanism, I consider a most treacherous appliance. I find it extremely difficult to prevent it from producing movements which are not necessary. It requires a very skilled operator.

I am afraid I have not up to the present had sufficient experience of the lingual arch, so am not competent to talk about it. It has undoubtedly a great future in front of it, as there appears to be no limit to the movements which it can produce.

I have no more to say, except to acknowledge my indebtedness to those whose ideas and cases I have made use of. I have to thank Mr. Humphreys and Mr. Shirlaw, of the Royal Dental Hospital, for making the appliances, and Miss Clifton, of the Royal Dental Hospital, for photographing the appliances, and preparing the slides in such an excellent manner. I have to also thank you, sir, and the members for their kind and patient attention.

Discussion.

Mr. J. H. Badcock said he entirely agreed with Mr. Evans as to the advisability of having one's apparatus as simple as possible. There were many points in Mr. Evans's paper that might be discussed; he would merely mention one of them. He would like to suggest that Mr. Evans might find a screw useful, not only as a means of expansion but to bring forward teeth either singly, or in a group, e.g. the lower incisors. Mr. Evans had said that he was in the habit of using vulcanite wedges. He (the speaker) suggested that instead of a wedge he might try a screw—a simple piece of wire threaded, with a slot cut in the end touching the teeth. If the patient were given a screwdriver which would fit that slot, the handle being marked with an arrow to show the patient which way to operate it, and if he were instructed to turn that screw a quarter of a turn every other day, it would be found that the tooth would be advanced just a desired distance in a definite time, quite easily and certainly; the lower incisors could often be advanced in this way. Sometimes the screws tended to rise up the backs of the teeth; but that occurred very seldom if one used a device for fixing which crossed the crowns of the teeth.

Mr. A. T. Pitts said Mr. Evans was in the very happy position of being able to hear views expressed by quite a considerable number of dentists at the Royal Dental Hospital, such views being very often violently opposed to one another; Mr. Evans had the advantage of seeing all sorts of different methods adopted, and of comparing them; he could therefore, as far as results were concerned, speak with a very great deal of authority. He (the speaker) was in entire agreement

with Mr. Evans with regard to the simplicity of appliances; he found himself more and more relying on a small number of appliances for doing the work. He also agreed that in many cases a removable appliance was better than a fixed appliance; but there were cases in which a fixed appliance was undoubtedly better. He had always found it rather difficult to retract upper incisors by means of a fixed appliance in which the force of an elastic was exerted on the front teeth; he found that one got a great deal of inflammation of the gums. With regard to the removable appliance for retracting teeth, particularly the concertina pattern, one had to bend the curves and put into the wire a considerable degree of torsion; there was always the risk in a removable appliance of the spring becoming the fixed point tending to dislodge the plate, rather than the plate being the fixed point. When one got this torsion in a continuous wire, it was rather apt to dislodge the plate. With regard to the use of finger springs on the Badcock plate, he thought there was much to be said for the trade union principle of "one man one job," and one plate one job; that is to say, if one were going to try to do two jobs with a plate, they should be two jobs of a similar character. Mr. Badcock had mentioned the use of a screw to bring out an incisor; that was a similar kind of movement; since the Badcock plate had to be bitten home for the nut to act, so also that biting home would force out the teeth; the two movements were as it were harmonious. He was thinking of the case of putting in a finger spring to bring out an incisor with a Badcock plate. Such a procedure was extremely liable to dislodge the plate. Sometimes one made the mistake of trying to accomplish too much with a single appliance; it was much better to accomplish one movement and then, if necessary, make another plate for a different type of movement.

MALOCCLUSION AND THE TEMPORARY DENTITION.*

By S. Wilson Charles, L.D.S.

It may be taken as a general rule that the temporary dentition foreshadows the permanent dentition. This is so universally recognised that it is unnecessary to bring forward any evidence to support the assertion. There are, of course, exceptions; an apparently abnormal temporary dentition may be replaced by a normal permanent dentition and vice versa. The exceptions to the rule are, however, not as numerous as they often appear to be. It is not necessary to stress the importance of the temporary dentition at a meeting of this society, but it is necessary to advocate the more extensive preaching of prevention both among the general public and among dentists. An appalling number of teeth are extracted every year, and an appalling number of mouths are ruined through ignorance or neglect; the extraction or premature loss of a temporary tooth should be an occasion for grief; and not an event of no importance.

The fact that in the majority of cases it is possible to predict a subsequent deformity is of considerable importance, because it will then permit early treatment, treatment which may be so applied that it almost amounts to prevention. The theory that malocclusion is caused by mechanical influence alone, is now realised

* *Transactions*, March 1st, 1926.

to be more or less incorrect ; I am inclined to think that the production of an irregularity by purely mechanical means is quite exceptional, because it will usually be found that the individual is suffering from feebleness of growth in some form or other. It is obvious that a child may suck its thumb with great vigour, and that it may move the teeth in much the same way that they would be moved by an apparatus, but it can be shown that if you remove the cause the teeth will probably resume their proper position. On the other hand, suppose that the child has bones which are affected by feebleness of growth, deficiency in lime salts, etc., it is more than possible that a permanent deformity may be produced. The term " feebleness of growth " has been used for convenience. It is now so familiar that no apology is needed : I use it with the meaning which Murk Jansen gives, namely that any nocive influence which acts on the body affects the growth of the bones, and that the more powerful this nocive influence, or the more early it is applied, the more influence will it have on the growth of the individual concerned.

It is not easy to decide whether any particular case is influenced by this derangement in growth or no. I conclude as the result of observations on animals and children, that the two parents may influence the offspring in two ways. In the first place, by the handing down of certain characteristics which are peculiar to the family ; these peculiarities, while abnormal in the majority of cases, may be considered as normal to the particular child. In the second place, by the quality of the cells from which they form the child. This is not a very good way of expressing what I mean, but it is so expressed for the following reasons : There is no doubt that parents as members of families hand on to their children, not only the characteristics of their families, but also the health of these families. In other words, both parents may come of what we usually call good stock or bad stock, or one may be good and the other bad. It is debatable whether this can produce what is called feebleness of growth in the case of the bad stock. It is of importance principally in the question of treatment, because it is obvious that a child coming from a bad stock is not so likely to respond to treatment as a child from a good stock, but affected by some accidental nocive agent.

How far one parent or even two can influence their offspring when they come of good stock but suffer from what we will, for want of a better word, call personal ill-health, is another question, and strictly speaking only applies to the father, because a mother in ill-health must of necessity affect the health of the child. I have taken a few paragraphs from a paper on Alcohol (*G. H. Gazette*, 22-12-23), by R. C. Brock, which show how very difficult it is to settle these questions and how very easy it is to make a mistake :

" In all social questions it is very difficult, almost impossible, to differentiate between cause and effect. Take for example the influence of the father's work on his children ; a man is a tailor or a cobbler because he is not physically capable of being a blacksmith or a docker, and if his children are below normal it is because of his inferior physique and not because of his employment. That is, the *inherent mental and physical characters of the parents may be productive of the environment.*

Or again, we may say if a woman goes out to work, her children suffer. That seems fairly clear. But is it? She probably goes out to work because her husband is not earning enough, and he is not earning enough because he is of inferior physique or intelligence, and his children would be inferior whether the mother went out to work or not. Actual statistics (in 1910) show that where the woman does not go out to work the average wage of her husband is 26*s*. 2*d*.; where the woman does go out it is 22*s*. 4*d*.

Thus we see that all the possible factors, direct and indirect, are hopelessly mixed up, and I am laying stress on this to show how broad-minded and careful one has to be."

This question is perhaps more academic than practical, and yet, as I have said, it may have an important bearing on treatment. The influence of nocive agents, which are productive of feebleness of growth, does not come into the question until the formation of the embyro, and how far or at what stage a nocive influence may affect the embryo or fœtus is difficult to decide.

It is usual to describe the fœtal mandible as being so arranged that the body and the ascending ramus are more or less in one straight line. This is obviously not correct; place the fœtal head so that the Frankfurt plane is in the horizontal plane, and the mandible will be seen to make an angle of something like 45 degrees with the horizontal. The picture we get of the mandible is very different from that when its lower border is allowed to rest on the table. As the mandible grows it is pushed forward and downward by the additions to the base of the cartilaginous wedge, and the tooth sacs or teeth rise so that what we may call the occlusal plane is constantly altering its position. The teeth therefore occupy a different arch at each successive period of growth.

It is possible when one looks at the mandible in this light, to determine with almost mathematical certainty what will be the result of interfering with growth. A gross interference with growth at the base of the wedge after the 55 mm. stage will obviously result in a very deformed mandible; slight or relatively slight interferences may result in a mandible which is slightly distal to normal. The growth which takes place along the main line of growth is quite independent of that which constantly alters the level of the occlusal plane of the teeth and, moreover, is independent of any forward growth of the bone supporting the teeth. This may be better expressed by stating that the teeth are carried forward and downward by the main growth of the mandible, but that they move upward and forward relative to this main line of growth and independant to it. As an illustration one may get a case in which both chin and teeth are postnormal, but one may also find many cases in which the teeth are postnormal and the chin is normal. Again, the chin may be markedly postnormal and the teeth only very slightly postnormal. This introduces a much larger question: the growth of the mandible and maxilla relative to the bones of the skull. The difficulty, practically the only difficulty, is the finding of a fixed point from which to make measurements.

I have digressed somewhat from my original argument about feebleness of growth. When I first started this work I anticipated that by the examination of microscopical sections one would be able to determine the effect of nocive agents on bone growth, that

there would be a marked difference between healthy or normal bone and unhealthy bone. Many difficulties have been encountered which it is hoped will be successfully overcome. At first I tried dogs, but I had a difficulty in collecting material which was reliable ; then I was fortunate to obtain a fair amount of human material, but it has not been as easy to make deductions from it as it would appear. In a short acute illness which is fatal the bone has not had time to become affected, and in the chronic disease it is necessary to examine specimens from different parts of the body before any deduction can be made. I have come to the conclusion that by using rats, or perhaps dogs, as controls, it may be possible to definitely determine the influence of any nocive agent. When I say control, I mean animals which have been suffering from disease, not normal animals.

The other method which one may adopt to see if any light can be thrown on the problem, is the method which was adopted by Murk Jansen ; the examination of families, the members of which have been born in quick succession, and where the mother has not been able to live under those circumstances which are necessary for the rearing of healthy children. Mr. Chapman dealt with this method in his presidential address last year so fully, that there is nothing for us to do now but produce family histories to add to his collection. I have examined a fair number of families, and I will show models of certain members of those families to illustrate various aspects of the question.

The influences which I have tried to determine are those which I spoke of at the commencement of this paper.

(1) The characteristics of the family which may be handed down to any or all the children.

(2) The influence of good or bad stock upon the children.

(3) The influence of the father's health when he comes of good stock.

(4) The influence of the mother's health when she comes of good stock.

(5) The influence of acute and chronic disease after birth.

(6) The effect of mechanical influence upon children suffering from feebleness of growth and those who are not.

The tentative conclusions one comes to are as follows :—

That feebleness of growth must be considered as a probable cause of malocclusion, but that it is necessary before doing so to eliminate the influence of heredity, with which must be associated the influence of bad stock, family characteristics, and certain evolutionary tendencies. [In the course of a few generations, breeders can change the appearance of animals so that they can hardly be recognised ; this may or may not have some influence on malocclusion, especially in the crossing of dissimilar types.]

That, generally speaking, mechanical influences are not the cause of malocclusion. Amniotic pressure is unlikely to cause it, except in extreme cases ; injury at birth would not appear to do so, unless the injury is of so grave a character that bones are definitely damaged, and this can hardly be considered as malocclusion.

That mechanical influence on the teeth and jaws of a child suffering

from feebleness of growth may cause malocclusion, but this same influence applied to a normal child would, or might, act as an apparatus for the correction of malocclusion—namely, it might move the teeth or alter the jaws, but on the influence being removed the teeth or jaws would tend to return to their original position.

On the other hand, many healthy children subject their teeth to various mechanical influences (thumb-sucking, etc.) without any bad effect. Experiments and experience prove that animals and children subjected to nocive influences after birth, recover from them with a fair chance of there not being any permanent injury if the influence be not effective for too long a period; but that when the nocive influence has operated before birth, the chance of permanent recovery is lessened considerably. There is in this case no comparison between prevention and cure; there is only prevention.

Discussion.

Mr. Harold Chapman said he was extremely pleased that Mr. Wilson Charles had taken on the task of investigating the etiology of some of the cases of malocclusion. The first four cases he had shown were most interesting. He had said that the children were brought up under miserable conditions, but he had not gathered that Mr. Wilson Charles had given any other factors, so that he imagined there were no nocive influences there. Although the conditions in which the children were brought up might be miserable, he did not regard them as nocive. It seemed to him that they must have come of good stock, and that the parents lived in healthy surroundings. Mr. Friel had told him several times that in one district in Ireland—he did not remember which it was, but Mr. Friel would be able to tell the members and correct him if he was wrong—where the people were very poor, their diet consisting almost entirely of potatoes and very little meat, the occlusions were extraordinarily good. That did seem to point to the fact that if the surroundings of the people were really healthy, tending rather towards the country life than towards the urban or city life, the chances were very much better. He himself had just had the opportunity of being in the South of France for several weeks, and there he had not noticed any marked deformity in the children as he walked about the streets. It was very different from what one observed in this country. There again probably, although the children were brought up under miserable conditions, conditions which we in this country would certainly regard as miserable, seeing that in the streets in which the people lived the sun had never entered for several hundred years, and in some cases a thousand years, still the population led an open-air life, and he supposed they got plenty of sunshine outside their own homes. He would have liked Mr. Charles to have given a little more detail than he had done, but still it was very valuable to have these cases brought forward in an attempt either to prove or disprove the views he had brought before the Society last year. He thanked Mr. Charles very heartily for having undertaken that work, and he hoped that at some future time he would go into more detail than he had on this occasion.

Dr. Sim Wallace said he had been much interested in Mr. Wilson Charles's work, and he was glad to see that on the whole he seemed to be more or less a follower of Murk Jansen. Was that so?

Mr. Wilson Charles: Yes, that is so.

Dr. Sim Wallace said he had nothing particular to say, but with regard to the nocive influences, he really thought it very largely came to a question of those nocive influences which resulted from an extraordinarily insanitary diet in vogue among civilised beings. The particular illnesses that children took might not be in themselves of very much consequence with regard to the development of the jaw,

but the resulting persistent loss of mechanical stimuli seemed to him to be at the root of the imperfect development of the jaw bones. He had just come home from Rangoon, and as he wanted to know what children ate there, he prowled about in the native quarter, but there he found hardly any "civilised" sweets. The principal "sweets" that the children seemed to indulge in were little bits of sugar-cane. About half of the crew were Lascars and the other half Englishmen with dento-facial deformities predominating. He had to examine the crew, and naturally looked into their mouths to see their teeth and their tongues. It was not difficult to see the teeth of the English part of the crew because they frequently fell down; some had their own teeth, but the condition of their mouths could hardly be considered satisfactory, to say the least of it. The teeth of the Lascars, however, were relatively very good. A noticeable thing about their mouths was that they had well-worn teeth. They had ground down their teeth somehow; whether they might attribute it to the nature of the food or not, it seemed to him indubitable that their teeth had been thoroughly well used, and he believed that that use started in very early life. The arches, on the whole, were very regular, and he believed that, as children, their mouths were far freer from sepsis than those of the average well-brought-up child that in later life went to Eton or Girton. The chief nocive influence, he thought, that was responsible in England for deficient bone development was ladling soft food into children and getting them into the habit of not masticating properly. He was sorry he had not anything more to contribute, but he thought that what Murk Jansen had been saying about the growth of bone pretty well solved the whole problem.

Mr. FRIEL said that the children he examined in the West of Ireland certainly had the most beautifully developed jaws, but they had a very considerable amount of decay or caries, and they had very inflamed gums, and he did not think Dr. Sim Wallace could ever say that their diet was very suitable; it was practically all potatoes.

Dr. SIM WALLACE: Good enough.

Mr. FRIEL said they ate an enormous quantity of potatoes—cooked potatoes; but they had very bad caries and very inflamed gums, but beautifully developed jaws. The only things he could find out about them was that they lived a good deal in the open air. Their houses were most insanitary; they slept with no ventilation. In recent years the houses had all been slated or had zinc roofs put on them by the Government, and they had done away with the thatched roof, which used to give a very considerable amount of ventilation, whereas they had none at all at present.

Mr. NORMAN GRAY said he would like to ask Mr. Charles if he had any experience of rickets. Dr. Hatfield had examined some four or five hundred cases, and to the surprise of everyone, instead of finding undeveloped arches they were generally very well developed. Perhaps Mr. Charles could say something about that.

Mr. H. C. HIGHTON said he wished to refer to Mr. Wilson Charles's description of cases where one got a deformity which was due probably to feebleness of growth, and not, perhaps, to mechanical action playing a great part. He said that because he had a family of five children under observation, all brought up in the same environment. The two elder children were bottle-fed and later lived on a fairly soft diet, and were allowed pretty much to choose their own food, and to go their own way; they were not limited as regards sweets. He had not had a chance of seeing their temporary dentition, but they had developed perfectly good arches, free from caries, and were both well-developed children. The three younger children were breast-fed and brought up on a fairly hard diet, and the soft food was eliminated. Those three children were more or less undersized, and had not nearly such good arches as the elder two children. One showed definite signs of irregularity, and they all had a fair amount of caries, and those

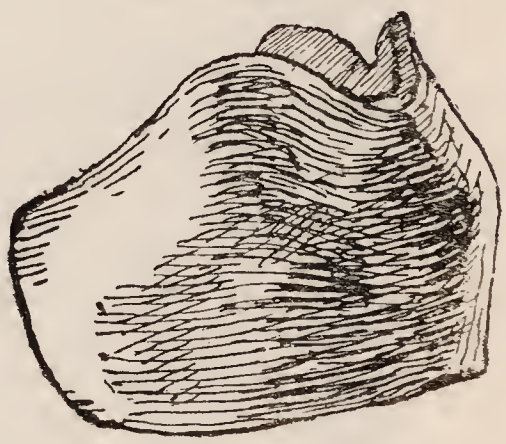
were children of the same family, brought up under the same conditions as the others.

The PRESIDENT said he would like to add his quota of thanks to Mr. Wilson Charles for his paper. The cases were very interesting, presented as they were, from different points of view, and they had led him to think that one could raise a study and produce statistics to prove anything. The four models which Mr. Wilson Charles had shown on the screen first had interested him more than any of the others from their similarity of development antero-posteriorly, and the fact that they were practically free from caries and showed good development. There was one important point which Mr. Charles had not mentioned at all, and that was whether the children whose models he had shown were survivors of large families. He imagined that the four children, or the four adults as they were then, from their dentition might have been the survivors of a large family, and one came back to that dreadful old saw, the " survival of the fittest." One or two of the speakers, among them Mr. Chapman and Dr. Sim Wallace, had mentioned the effect of rural life as against urban life. His own experience was that there was nothing in that. He had practised in the country for over twenty years, and also in the town, and the dentition of the country child under the same financial conditions was just about the same. He thought it was worthy of notice in connection with Mr. Chapman's remark with regard to the children in that part of France to which he went, that very serious regard must be paid to the diet. They possibly had very little sugar in the form of chemical or commercial sugar as used in England. Their drink possibly was a rough, crude wine ; they did not take such farinaceous food as English children did, and they foraged for their food very largely, and those who saw the poor child in the hospital practice, who came with a clean healthy mouth (and many of them did) would agree that the children who survived were those who had to forage for their food. There was never enough, but if they lived to the time when they could develop a secondary dentition it was going to be a good one very often. The child who was pampered and fed on soft pappy mush ought not to expect a good dental development. Combined with that, he thought regard must be had to parental responsibility in those matters. A good many people were very fond of talking about teeth, but they disregarded very largely the other physical developments—and how many of their patients who came to them with malformed dentition were not malformed in any other way ? The subject of bone growth, of course, was to him particularly interesting, and he was more than satisfied to feel that one or two speakers thought that Murk Jansen had solved the problem. As far as he understood it, from what he had read both of Jansen's work and that of Woolf and every other bone man that had written, they knew very little more about bone growth than Hunter did, and he thought there was a lot to come yet. In conclusion, he thanked Mr. Wilson Charles for his very interesting paper, and those who had spoken, for their contributions to the discussion.

Mr. WILSON CHARLES, in reply, said he must apologise for the haste in which he went over the various cases. There was a lot he might have said about each one. With regard to the first one he had shown, the children were from a family eight in number, one of whom had died. The four were the younger members of the family. The eldest one was 20 and the youngest about 14, and they had lived under miserable conditions. He ought to have enlarged on that, of course. Their father was so poor, owing to the conditions under which casual farm labourers lived in those days, and apparently still did, that he had very great difficulty in making ends meet. He was very often on the sick list, but he could not think that that was due to anything more than an accident. He did not think the man could have been of bad stock ; he must have been a perfectly fit man, but that his illness was more or less accidental, and the children, he knew,

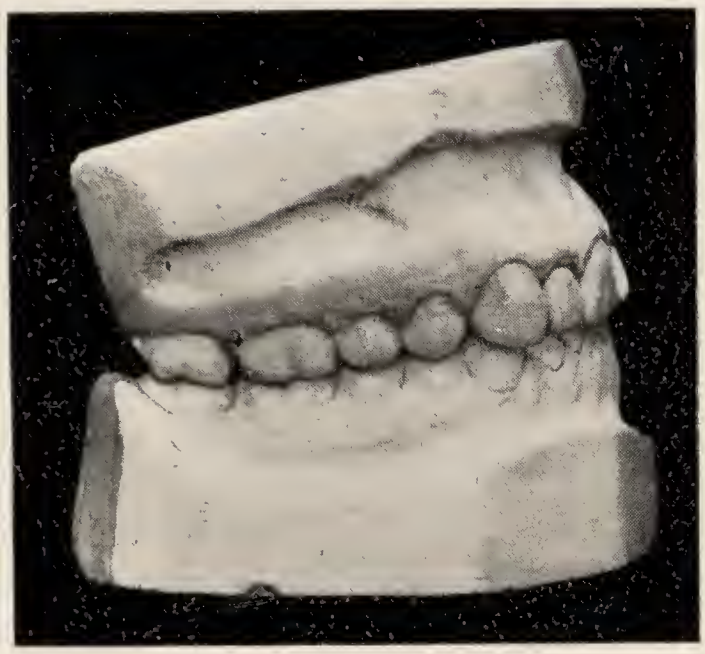
were very often in the habit of going to the fields to get turnips, etc., to eat. Dr. Sim Wallace had introduced the question of Indians and the like. He had resisted the temptation, when he was writing the notes for his paper, to discuss the question of diet, and he did not think he ought to enter upon it then. He had lived for three years in East and Central Africa, and had considerable experience, or at least a fair experience, of primitive tribes—that is, as primitive as one could get them to-day—and he was not at all sure that current ideas about diet were quite correct. He was perfectly certain that there was something besides soft food which was influencing the question. There were many tribes in Africa which had really wonderful mouths, and never ate anything but soft foods. For instance, the Buganda lived principally on bananas, which were certainly soft enough. Mr. Friel had mentioned about the inflamed gums and caries of the West of Ireland. That reminded him of large numbers of native tribes which he had examined, where one often got pyorrhœa, which, of course, might be due to the soft food, but it occurred even in those cases where they took hard food, so it was a little difficult to decide what was the cause. Mr. Norman Gray had asked a question about rickets. He was doing work on that at the present time, but he was afraid at the moment he was really not in a position to say much about it. Mr. Cale-Matthews had mentioned the question of rural life. Most of the children whose models he had shown had lived in the country all their lives.

A DEMONSTRATION was given of the Mouth Valve of Mr. George Northcroft and Mr. Warwick James, which found considerable recognition in the States. At the University of Pennsylvania Graduate School it was not possible to treat all the orthodontic cases presenting. Accurate plaster impressions were taken and the children sent away for six months. Some cases of pronounced mouth-breathers were given these aluminium mouth-covers to wear at night. In quite a number of cases a marked improvement was noticeable six months later, the pernicious habit being checked or less pronounced. Not infrequently upper incisors were found to be retracted, due to the mechanical pressure of the lips on the shield. The mouth-cover is made of cast aluminium. A loosely-fitting wax pattern is made over the record models or, better still, from a closed mouth compound impression of the buccal surfaces of both upper and lower teeth. Care must be taken to get an impression reaching to the mucous fold in order to have the mouth-cover as deep as possible. Use a double thickness of ordinary pink wax. The finished aluminium must be carefully polished inside and out, and freed from muscle attachments.



A CASE SHOWING TOOTH MOVEMENT.*

By A. L. Packham, L.D.S.



The patient, a girl of 16½ years, presented with a good dentition; there was some caries, but the occlusion on the left side was perfect. At the age of 12 the right upper central incisor was injured by a fall and the root was immediately removed. The right lower incisor was removed at about the same time for the relief of crowding in this region. No treatment whatever has been undertaken. The models show the extent to which nature has repaired these mutilations. The upper left lateral has moved into the space occupied by the central; all the teeth posterior to it have moved forward in accommodation. The case now appears as one of unilateral post-normal occlusion, and (such was the good appearance of the dentition) it was not until the writer was searching for a cause of this deformity that the loss of the incisor was appreciated.

* *Transactions* of British Society for the Study of Orthodontics.

An ordinary meeting was held on Monday, May 3rd, 1926, Mr. G. F. Cale-Matthews (President) in the chair.

The President announced that Mr. Maxwell Stevens, who was in charge of the Investigation Committee, wished to bring forward once again his desire for models of normal occlusion and those of twins, whether normal or abnormal, and also models of members of the same family showing similar dental irregularities or characteristics. Members of the same family should, if possible, be parents and children —grandparents also if they could be obtained. The Hon. Secretary would be pleased to hand to any member or visitor forms for the histories of children of the same family.

Demonstrations.

The following demonstrations were given : "New Locks for Lingual Arches," Mr. J. H. Badcock ; "Mouth Cover for Mouth Breathers," Mr. Norman Gray ; "An Attachment for Vulcanite Orthodontic Plates," Mr. C. S. Morris ; "A Plane Blade Sharpener," Mr. G. Northcroft ; "Soft Soldering," Mr. H. G. Watkin.

Mr. H. C. Highton demonstrated the technique for making platinum bands for first molars, and the attachment of vertical lingual half-round tubes to same. The construction of the lingual arch, together with the various attachments, viz. locks, accessory springs, etc., also buccal arch used in conjunction with same with Dr. Oliver's lock for buccal arch.

A modified form of my attachment which was introduced some years ago : Mr. C. S. Morris. The original attachment was introduced to retain removable plates without the use of a Jackson's crib. It consisted in fixing a spur just below the fissure in the palatal or lingual surface of the deciduous molars under which a spring on the plate was made. Subsequently a band was used and the spur soldered on the band. The modification demonstrated consisted in putting the spur on to the spring and letting it engage under a wire soldered to the band attached to the tooth. This wire is soldered so as to pass across the approximal space in front or behind, mesially or distally as may be required for balance. In this way fitting a plate in the mouth is made much easier because the plate does not have to be cut to slip past the spur on the tooth, and also, in case the plate has to be left out of the mouth for any reason, the spur does not irritate the tongue.

Ordinary Meeting, Monday, October 4th, 1926. The chair was occupied by the President of the Society, Mr. G. F. Cale-Matthews.

The President, in introducing the reader of the paper, said that, as the members knew, a paper was to be read by Professor Brash dealing with "Further Experimental Work on the Growth of the Jaws and the Relation of Bone Growth to the Eruption of the Teeth." That might be rather an epoch-making subject, but whether that were so or not, the Council felt that they would not like to curtail the Professor's paper, especially in view of the enormous amount of material in the way of specimens that he had brought with him. The Council therefore asked members to sanction a rather unusual procedure, namely, that the present meeting be devoted to the reading of Professor Brash's paper only. It was further proposed that the meeting to be held in December should be devoted to a discussion on that evening's paper. In the meantime the paper would be printed and circulated to all the members.

On the motion being put to the meeting it was carried unanimously.

A letter which had been received by the Secretary from Sir Arthur Keith was then read, in which the writer expressed his regrets for his enforced absence from the meeting.

The PRESIDENT expressed the hope that Sir Arthur Keith would be able to attend in December and to take part in the discussion.

On the motion of Mr. NORTHCROFT, a hearty vote of thanks was accorded to Professor Brash for his paper, and the meeting terminated.

THE GROWTH OF THE ALVEOLAR BONE AND ITS RELATION TO THE MOVEMENTS OF THE TEETH, INCLUDING ERUPTION.*

By James C. Brash, M.C., M.A., M.D.,
Professor of Anatomy, University of Birmingham.

(Read before the British Society for the Study of Orthodontics.)

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* The expenses of the work upon which this paper is based have been borne by a grant from the Medical Research Council, and I am also indebted to the Research Committee of the University of Birmingham for the facilities they have afforded me. I should like also to acknowledge the willing help of my laboratory assistant, Mr. E. Sims, in the preparation of specimens.

Introduction.

In the course of the first of the lectures which I delivered in 1924 in the series on the Growth of the Jaws, arranged by the Dental Board, I made some general remarks on the growth of the alveolar bone and pointed out that "the increase of the alveolar bone by surface additions leading in the maxillæ to a strong downward, outward and forward movement of the alveolar arch, and in the mandible to a similar movement of less extent and somewhat different character, is important from three points of view: (1) the addition to the height of the jaws that is thereby achieved; (2) in relation to the eruption of the teeth; (3) in relation to the changing form of the alveolar arches."

The first two of these aspects of the growth of the alveolar bone I then discussed quite briefly, with a general note on the question of the movements of the teeth, erupting and fully erupted, in the alveolar bone; the third aspect, that concerning the important changes which take place in the alveolar arches during the change from the deciduous to the permanent dentition, was discussed more fully. This discussion, however, was based upon only a few observations of the actual manner in which the alveolar bone grows in the jaws of madder-fed animals, and chiefly upon all the available data concerning growth changes as determined in the human jaws by measurements. I included a fairly full account of the important work of G. Franke, whose premature death in 1924 was a great loss to dental science, and I arrived at the conclusion that "the arches (of the milk and the permanent dentitions) are not identical, the succession is not an exactly vertical succession, the characteristic form of the milk arch is changed to the characteristic form of the permanent arch by growth in width of the posterior part of the arch, which takes place during the tooth change, and by the non-vertical succession of the anterior teeth; moreover, as a result of the addition to the length of the face during the period of change by general growth of the alveolar bone, the arch is entirely reconstituted and comes to occupy a new plane relative to the body of the jaw."

Franke's conception of the relation of the deciduous and permanent arches was then illustrated by two of his diagrams, again reproduced (Fig. 1), which exhibit them, (*a*) maxillary and (*b*) mandibular, superimposed one on the other. The change from the deciduous to the permanent arch is brought about, according to Franke's measurements, by the increased width of the base of the arch, combined with a diminution of its "length." The "length of the alveolar arch" depends upon the sum of the measurements of the anterior ten teeth, and the decrease, which Franke found, of about 4 mm. in the mandibular and 2 mm. in the maxillary, is due to the smaller diameters of the premolars as compared with the milk molars in each jaw, combined in the maxillæ with the greatly increased size of the permanent incisors, especially the central. "It follows that with increased width of the base of the arch and diminution of its length the arch must become flatter and the height therefore less, and since the upper increases more in width but at the same time decreases less in length there is a compensation and the heights remain relatively the same."

But, having given an account of Franke's work, it was pointed out that "this conception of the relation of the two arches depends entirely upon the assumption that the first permanent molars move only laterally and not at all forwards in the jaw, and that the

flattening of the arch which takes place is partly due to the widening of its base and partly to the permanent teeth occupying a position further back because, especially in the mandible, their added diameters are less than those of the milk. While this supposition is evidently of the greatest value for the due comparison of the arches, it must be admitted that the same result would be brought about by an outward and forward movement of the first permanent molars which, although there is no sure evidence that it takes place, must be postulated if we wish to superimpose the arches by means of the incisors."

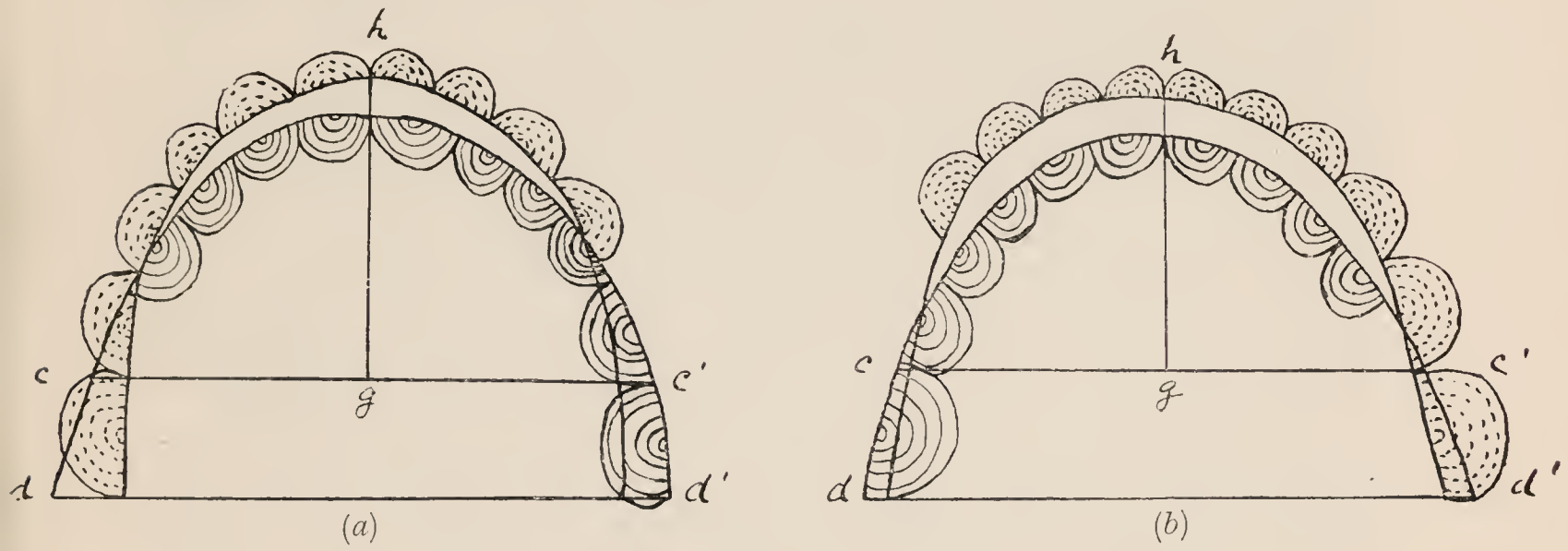

FIG. 1.—Superimposed alveolar arches, milk and permanent, of (*a*) the maxillæ, and (*b*) the mandible. The milk alveoli are indicated by interrupted lines, the permanent by continuous. (After Franke. Block kindly lent by the Dental Board of the U.K.)

In other words, after a discussion of the important question whether there can be found a fixed point from which to take measurements of the alveolar arches and to determine the relative position of the teeth in jaws of different ages, the conclusion had been reached that in the absence, owing to growth changes, of any such fixed point on the bone itself, the first permanent molar, since in a sense it belongs to both dentitions, might conveniently be used for that purpose. It was then recognised, however, that measurements based upon that tooth or its alveolus could not be taken as evidence of actual increase or decrease from a fixed point, since there was clear proof that during the period of tooth change it moves in the alveolar border not only upwards, in conformity with the general upward growth of the border and the consequent general upward movement of all the teeth, but also outwards, as is obvious from the increase of the intermolar measurement and also from the appearances, in madder-fed animals, of the bone forming its alveoli.

Nor has there hitherto been any definite evidence adduced to settle the question whether it may also move in the alveolar bone in a proximo-distal line, actually and not merely relatively to the ramus of the mandible or the malar process of the maxilla as these move backwards. It is sufficiently obvious that measurements which depend upon the position of a tooth moving certainly in two directions, and possibly at the same time in a third, must be relative only.

The object of this paper is to discuss a little more fully the whole question of the growth of the alveolar bone in the light of further experimental material, with special reference to its importance in relation to the growth of the jaws as a whole and to the movements

of the teeth in the alveolar bone, including the movements which take place during their eruption.

The Madder Method.

The evidence upon which I propose to base certain conclusions has been obtained by observation of the jaws of madder-fed animals, by the measurement of the actual amount of new bone laid down in different situations during given periods and by interpretation of the meaning of its distribution. It may be well, therefore, in the first place to give a brief account of the madder method and to comment on some of its difficulties, not only for the benefit of those who may be not quite familiar with it, but also in view of certain recent rather emphatic statements tending to throw doubt on its value. These statements, having been made in a paper published in the *British Dental Journal*, may perhaps have led some who are interested in the problem of the growth of the jaws to discount the conclusions at which those who employ the method are arriving. I do not intend, however, to deal here with these criticisms, to which a detailed reply has already appeared in the same journal ; I shall content myself with a simple statement of the principles, the difficulties and the value of the method.

I omit also any historical references, having already given elsewhere a short account of the origin and progress of the application of the properties of madder to the study of the growth of bones. Briefly stated, the principle is that when madder (the ground root of the madder plant, *Rubia tinctorum*) is administered with the food in suitable quantities to suitable animals, the bones acquire a red colour. This colour is found to affect the whole of the bone, but is deeper in the growing parts : the sites of the growth of the bone may therefore be recognised after a suitable period of " madder-feeding " by the presence of the deeply stained layers. With this " direct method," however, since the old bone is at the same time slightly coloured, the line of demarcation is not particularly sharp, and it has been found that considerably better results are to be obtained by an " indirect " procedure. First, it is ensured that the bone is deeply stained throughout by giving madder continuously, preferably from birth, for a sufficient time, and then it is omitted for any period during which the growth of the bone is to be determined. Any excess of madder in the circulation appears to be very rapidly eliminated, principally by the kidneys, and the new bone laid down during the " non-madder " period remains uncoloured and is thus marked off very sharply indeed from the previously coloured bone. The invariable results obtained with the same bone at the same stage of growth demonstrate the reliability of the " indirect method," which I now always employ.

There are, however, certain difficulties in the way of correct interpretation of the results obtained ; these difficulties, which I do not propose to discuss here in any detail, render it necessary, in the first instance at any rate, to use an animal with sufficiently large bones to enable the observer to distinguish easily between the different areas of growth, and to interpret correctly the changes from red to white areas. The larger the animal also, the more accurate will be the measurement of growth increments.

There are five sources of difficulty in the use of the madder method. The first, that with the " direct " method the line of

separation between new and old bone is not sharply marked, is entirely overcome by the use of the "indirect." But the indirect method itself, although the line of demarcation is very sharp, introduces further questions, entirely concerned, however, with the measurement of the amount of new bone and not at all with its distribution. In the first place, the exact time necessary for the elimination of circulating madder, although certainly very short, is unknown; it may therefore be that the bone continues to be coloured for a short time after the madder has been withdrawn. But, on the other hand, it is to be observed that the growing areas of an animal killed during a madder period exhibit a very thin pellicle of feebly stained, because incompletely ossified, bone. Without discussing these two possible sources of error in opposite directions in measuring the thickness of new bone, I may say that, whether they may cancel each other or not, owing to the exceeding sharpness of the transition from old red to new white bone, and in view of the certainty that a difference resulting from either of them must be extremely minute, they may safely be neglected.

The fourth source of difficulty is that owing to the amount of absorption proceeding all over the skeleton during its growth, some of the madder already deposited in the bones is set free into the circulation, and this appears to be sufficient, in spite of rapid elimination, to impart a very slight creamy tinge to the new bone as it is laid down. But this fact constitutes no "difficulty" at all, as the tinge is never sufficient to interfere in the very slightest with the sharp line of demarcation between "maddered" and "non-maddered" bone; it is of no importance whatever, so far as interpretation or measurement are concerned.

Lastly there is the problem of interpreting the areas which remain red after a non-madder period. On this point I need only say that there are several means of determining how far these areas represent stationary surfaces, and how far they are accounted for—and this is the explanation of the vast majority—by the process of absorption.

All the difficulties in the way of the interpretation of the results obtained by the madder method being appreciated and duly taken into account, it remains the most powerful instrument for the discovery of the mode of growth of bones, including the actual and relative extent of deposition and absorption at any part of the skeleton, and, I may add, the relation to the growth of the skull of the synchondroses and sutures which unite its various component bones.

I may note here that in the course of a recent experimental investigation of the vitamin content of madder, carried out in co-operation with my colleague, Professor Haswell Wilson, on a considerable number of rats, we have also taken the opportunity of testing different preparations of the two main colouring principles, alizarin and purpurin, which are contained in the madder root. We have arrived at certain conclusions, which we hope shortly to publish in a paper on the vitamin content of madder and the relation of its chemical composition to its staining properties. Briefly, we find that the vitamin content of commercial madder, as supplied to us, is negligible, this conclusion opening the way to experiments on animals with deficiency diets combined with madder, and that, whereas both alizarin and purpurin are efficacious

alone in staining the bones, purpurin is the more powerful, contrary to the received opinion that it is to the alizarin that the madder root owes this property. The purpurin content of madder is therefore believed to be the more important from this point of view, although alizarin is the substance which gave to madder its commercial value as a dyestuff ; it was the production of alizarin artificially—the first of the vegetable dyestuffs to be synthesised by the German chemists, Graebe and Liebermann, in 1869—that gradually led to the great restriction of the madder industry.

The General Principles of the Growth of Bone.

Before we proceed to the consideration of the growth of the alveolar bone in detail, the general principles of the growth of bone, as demonstrated by the madder method, may be summarised as follows. In the first place, there is no evidence of the growth of bones in size by interstitial deposit, although interstitial changes, by deposit and absorption, undoubtedly occur. Thus, compact bone may be changed to cancellous, or the process reversed, without the least effect upon the space occupied by the piece of bone concerned. Apart from the ossification of cartilage, in such situations as the epiphyseal lines, articular surfaces or the synchondroses of the base of the skull, all increase in the size of bones, or in the thickness of any part of them, is due to the deposit of new bone on their free surfaces, either external or internal. All changes in the shape of bones, as well as the retention of form by the maintenance of the relative position of different points as increase in size takes place, are due to a combination of surface deposit and surface absorption which in all parts of the skeleton proceed simultaneously. This includes the enlargement of cavities, such as the marrow cavities of long bones and the air sinuses in the skull. The chief rôle of absorption is found in the maintenance of the general form of a bone as it grows in size ; compelling examples of this process are to be found not only in the moulding of the long bones as they grow in length, but also in the growth of the mandible and maxillæ. Compare the expanding growth of the shaft of the femur, which increases so much in diameter by external deposit and internal absorption that a specimen from a newborn child may be placed inside the medullary cavity of an adult bone, with the great increase of the surface area of the maxilla combined with the increasing capacity of the antrum within it. The general increase in size of the cranium, and in its capacity as the brain grows, provides another excellent illustration, resembling in essentials, like the growth of the maxilla, the increase in circumference and in the cavity of the shaft of the femur ; the changes that take place in the skull, however, are complicated by the question of the relation of the sutures between the different bones to the growth of the whole.

Surface deposit and surface absorption are therefore the means by which bones grow in size and change their shape, and it is to the application of these principles to the growth of the alveolar bone that I now proceed. I propose to deal in turn with each of the three aspects of alveolar growth to which I have already referred ; considering in the first place the increase in height of the jaws as a whole ; secondly the movements of the teeth in the alveolar border, including their eruption ; and finally referring briefly to the importance of the conclusions reached for our conception of the changing form of the alveolar arches.

The Relation of Alveolar Growth to the General Growth of the Jaws.

The general dependence of the form of the alveolar border upon the presence of the teeth, and the association of bone growth in this region with their eruption have long been commonplaces of observation. "It is impossible to insist too strongly upon this fact," says Tomes, "that the sockets grow up with and are moulded around the teeth as the latter elongate. Teeth do not come down and take possession of sockets more or less ready-made and pre-existent, but the socket is subservient to the position of the tooth; wherever the tooth may chance to get, there its socket will be built up round it. Upon the proper appreciation of this fact depends our whole understanding of the mechanism of teething."

But it has to be recognised that all the changes which take place in the alveolar border have generally been considered to be local changes only, the series of events comprising the building up of milk sockets, the replacing of these by permanent sockets and the final absorption of the latter in their turn constituting the history of an alveolar border which remains the same border throughout. Tomes again sums up this view in a well-known passage in the *Manual of Dental Anatomy*: "We may now revert to the phenomena observed in the alveolar processes. They were first built up as crypts with overhanging edges enclosing the temporary teeth; then they were swept away, in great part, to allow of the eruption of the temporary teeth; and next they were rebuilt about their necks to form their sockets. Once more, at the fall of the deciduous teeth, the alveoli are swept away, the crypts of the permanent teeth are widely opened, and the permanent come down through the gaping orifices. When they have done so, the bone is reformed so as to closely embrace their necks, and this at a period when but little of the root has been completed."

There is little suggestion here that the alveoli which are "swept away" at the fall of the deciduous teeth are not the same alveoli that were previously "built about their necks to form their sockets," or that in general all these changes, described with accuracy in a relative sense, are taking place in an alveolar border which as a whole, in spite of local absorptions, is steadily growing throughout. While undoubtedly in other passages in his account of the general growth of the mandible Tomes infers that there is considerable growth in height of the alveolar border—even to the extent of stating that in his opinion the deepening of the alveolar portion of the jaw "constitutes almost the whole increase in vertical dimensions during the passage from the child's to the adult's form of jaw"—yet these statements must be read in the light of his conception that the alveolar and basal portions of the jaw are always distinct, and separated by a line which he draws on the basis of the dental canal and mental foramen. The impression that is left on the reader is that the dental canal itself does not change, that the history of the parts above and below it is quite different, and that the growth of the alveolar border is limited to providing for the greater length of the roots of the permanent teeth.

It has indeed been recognised by some lately that the occlusal plane is constantly undergoing an alteration of level throughout the growth period, but the tendency is to ascribe this to the growth of the bones of the skull, so that the occlusal plane is "thrust downwards and forwards" to a lower level.

I make this introduction because I propose to show that the growth of the alveolar border is a very important factor in the increasing height of the jaws, that its activity is by no means limited to building up the alveoli for the teeth and providing for the greater length of root of the permanent teeth, and that the true change in the occlusal plane, so far as the bone is concerned, is not a mere alteration of level in relation to the base of the skull, but consists in a continuous alteration from both maxillary and mandibular sides by constant additions to the actual surfaces of the alveolar borders. Local changes there are in consequence of the eruption of the teeth, but they do not interfere with the constant change in the level of the border as a whole ; this I hope to demonstrate by actual measurements of the rise of the alveolar borders in the jaws of the pig.

If we examine the mandible or maxilla of a growing pig which has been the subject of madder-feeding by the indirect method, then we shall find that the whole of the alveolar border, irrespective of the state of the eruption of the teeth, will show the white edge that denotes bone growth (Plate II and Fig. 2). Moreover, where teeth are erupting, the local absorption which is taking place is seen to affect as a general rule only the outer wall of the crypt, leaving the inner wall to maintain the general continuity of the rising level of the border, a process which cannot be accurately described as a " sweeping away " of the alveoli or of the border. Here then is evidence of the constant upward growth of the alveolar border as a whole, and a closer examination reveals that new bone has been added not only on the surface of the border itself, including the outer and inner edges and the edges of the inter-alveolar septa, but also on the walls of all the alveoli. For the moment we are concerned only with the growth of the edges ; the new bone formation in the alveoli will be considered later in relation to the movements of the teeth in the growing border.

The growth of the alveolar border leads therefore directly to an increase in the depth of the bodies of the mandible and the maxilla. The problem in the mandible is to determine to what extent it is responsible, as compared with additions to the lower border, for increase in the depth of the body as a whole ; from this point of view the position of the mandibular canal may be safely neglected and the whole difficulty of finding a " fixed line " avoided, since we are in possession of the means to measure the respective increments directly. In the maxilla, on the other hand, the problem is to determine to what extent the growth of the alveolar border is responsible for the similar increase in the depth of the body, as compared with growth at the cranial side of the bone—a question that is complicated by the articulation of the maxilla with other bones of the skull and by the presence of the superior maxillary canal, which in the pig's maxilla lies below instead of above the maxillary sinus as in the human bone, and of the maxillary sinus itself (Fig. 2). On account of the difficulty introduced by the sutural connections above, the growth directions of the maxillary canal and the maxillary antrum have to be considered from the beginning, but the difficulty is more than balanced by the advantage of the extra surfaces available for observation.

We may note here that the structure of the maxilla and the mandible is essentially the same ; in each there is a cavity in relation to which the nerve supply of the teeth runs : in the one the cavity is

occupied by air separated from the bone by muco-periosteum, in the other by fatty marrow separated from the bone by endosteum. In the human skull the ultimate position occupied in each by the nerve may perhaps be taken as an index of the proportion contributed by alveolar growth to the ultimate depth of the bones. The growth history of the mandibular canal, however, does not immediately concern the present part of the subject, though certain observations, confirmatory of the conclusions drawn from direct measurements, will later be mentioned.

So much for a general statement of the continuous growth of the alveolar border. What can we learn as to the amount and rate of the growth by actual measurement ?

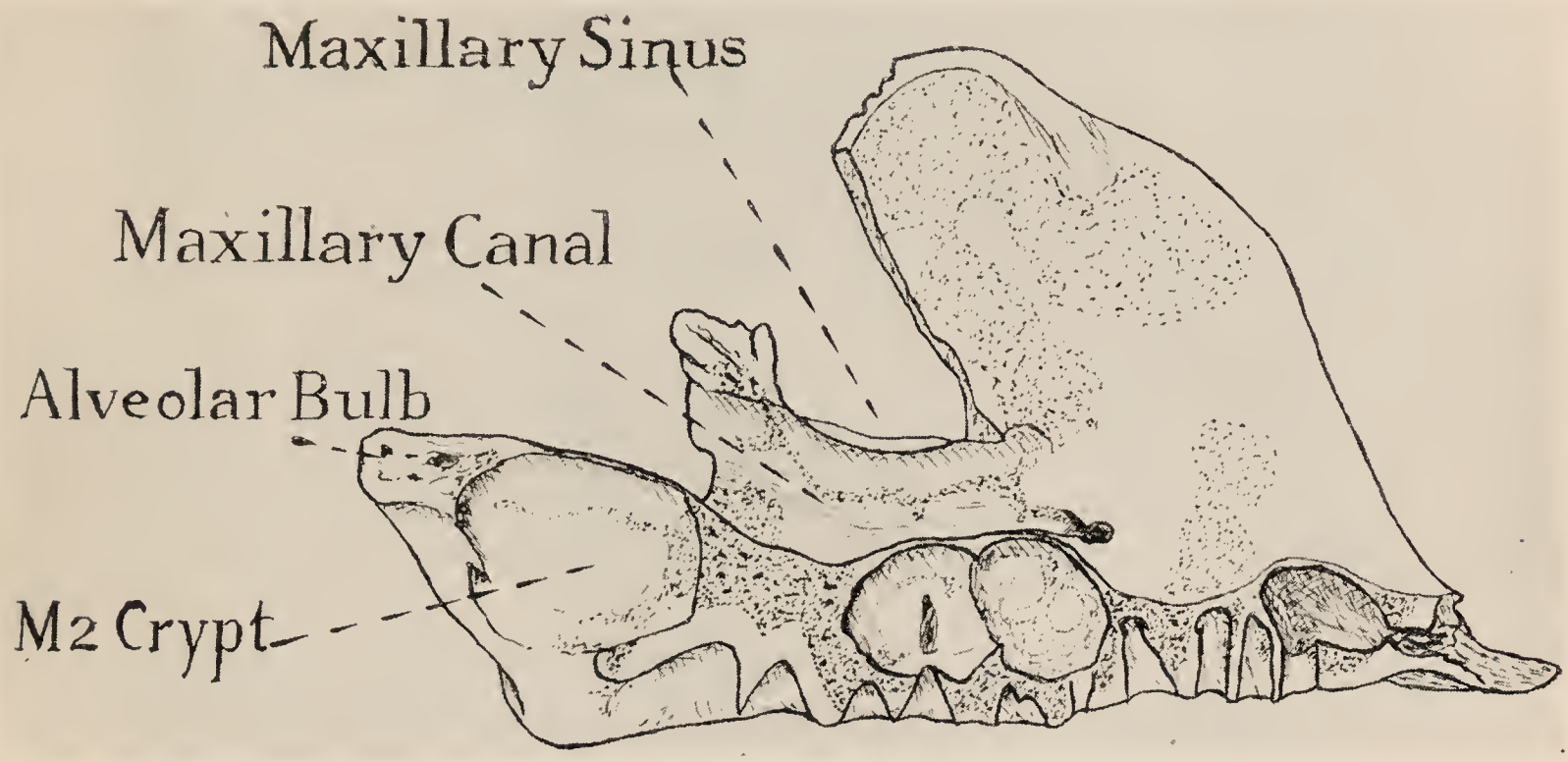

FIG. 2.—Sagittal section of the right maxilla of a pig, 24 weeks old, to show the relation of the maxillary canal and the floor of the maxillary sinus to the alveolar border, and the growth of the alveolar edge. The stippled areas represent old bone, and the white areas new bone, laid down during a period of four weeks. Nat. size. *Cf.* Figs. 5, 6 and 7.

The procedure has been as follows. Projection drawings, for subsequent use, having first been made of different aspects of the mandibles and maxillæ of madder-fed pigs, a large number of preliminary measurements was taken, including approximate determinations of growth increments wherever possible. The left halves of the mandibles and the left maxillæ were then sectioned with a fine fret-saw into twenty to thirty pieces each, mostly at right angles to the alveolar border, and all growth increments measured on the cut surfaces. The right halves of the mandibles and the right maxillæ were in the first instance retained intact as controls, to be subsequently sectioned, the half mandibles by a fronto-sagittal cut, passing through all the alveoli, into buccal and lingual portions, and the maxillæ in the horizontal plane, separating the alveolar border and exposing the walls of the maxillary canal and sinus.

All measurements have been taken with a sliding gauge, provided with a vernier scale reading to ·1 mm. The actual readings have been recorded in every case, although it is recognised that the error of

observation in making measurements depending upon transition from red to white bone, especially on curved surfaces, may amount to more than one-tenth of a millimetre. The growth increments on the roots of all the teeth which show them from both sides of each jaw have also been measured, and as far as possible the depths of all the alveoli ; note has also been taken of the progress of absorption of the roots of the milk teeth in the later stages. I have also considered the question, and made some measurements, of the apparent additions to the height of the bodies of the mandible and maxilla by the growth of their non-alveolar borders, though this is by no means so simple as it may appear.

The data so obtained have enabled me in the first place to calculate the individual and average rates of the growth of the alveolar bone, to come to a conclusion regarding the proportions contributed to the height of the jaws by alveolar and other growth, and to compare the increase in the height due to alveolar growth alone with the simultaneous increase or diminution by absorption in the length of the teeth themselves and the increase or decrease in the depths of the alveoli. I have also been able to compare the distances travelled by the crowns of erupting teeth with the simultaneous increases in the lengths of their roots. The data derived from all the mandibles and maxillæ available from madder-fed pigs, though still very far from complete, are already much too extensive to print here in full ; it is hoped to publish them later in the first of a series of " Studies on the Growth of the Skull." In the meantime all that can be attempted is to present a few typical measurements illustrative of the general conclusions to which the full series increasingly points.

Bone Additions to the Mandibular Alveolar Border of the Pig from the Tenth to the Thirty-second Week.

Selecting three mandibles at intervals during this period, Nos. 15, 12 and 2, from pigs of 13, 20 and 28 weeks respectively, I find that the vertical growth which has taken place in different regions of the alveolar border is as set out in the following table. It is to be noted that in this and the subsequent tables the figures for Nos. 12 and 2 represent four weeks' growth, whereas in No. 15 two weeks only had elapsed since the madder was stopped.

It will be noticed that the amount of addition to the alveolar border, at its maximum in the incisor region, diminishes in general towards the ramus ; the increase in sections 13, 14 and 15 of No. 12 is related to the state of eruption of the first permanent molar. This table gives the actual amounts added in the periods stated, and a calculation of the rate at which the alveolar bone is growing shows that it ranges in these pigs from a minimum of ·2 mm. to a maximum of 3 mm. per week. It should be pointed out, however, that the minimum occurs on the centre of the edge of the alveolus of the first permanent molar in No. 2, and that approximately double the growth has taken place immediately in front and behind this point ; this indicates a levelling up of the alveolar edge in the later stages of the eruption of the tooth. The average growth of the alveolar edge in these three pigs is at the rate of ·875 mm. per week, which it may be noted, as a matter of interest not without its importance for the study of the growth of the mandible as a whole, is rather more than half the rate at which the posterior border grows backwards.

The Relation Between the Growth of the Alveolar and the Lower Borders of the Mandible in the Pig.

If we now turn to the lower border of the mandible and measure the additions there in the same sections, we find a rather unexpected and very different state of affairs. Unexpected as they are, the facts of the amount and distribution of growth on the lower border of the mandible are of the highest importance for a correct conception of mandibular growth as a whole.

Table I.

Growth Increments in the Alveolar and Lower Borders of the Mandible of the Pig.

	Alveolar Border.			Lower Border.		
	No. 15.	No. 12.	No. 2.	No. 15.	No. 12.	No. 2.
Age of Pig ...	13 wks.	20 wks.	28 wks.			
Period of Growth	2 wks.	4 wks.	4 wks.			
Sections.						
1. i1 ...	4·8	6·6	2·6	Nil.	Nil.	Nil.
2. i2 ...	6	6·1	2·5	Nil.	Nil.?	Trace.
3. i3 ...	3·7	4·9	1·4	—	—	—
4. c	4·1	3·7	2	—	—	—
5. dm1 ...	4·6	2	1·6	—	—	—
6. dm2. ant.	2·7	3·3	2·4	—	—	—
7. dm2. post.	2·7	3·3	1·8	·1	1	·4
8. dm3. ant.	3·9	3·5	1·4	·1?	1·5	·6
9. dm3. post.	2·9	3·7	2	·1?	1·3	·7
10. dm4. ant.	2·1	3·5	1·4	·2	1·2	·5
11. dm4. cent.	1·2	3·3	1·1	·2	1·5	·4
12. dm4. post.	1	3	1·2	·2	1·3	·5
13. M1. ant.	1·9	4·9	1·1	·2	·9	·4
14. M1. cent.	1·9	4·9	·8	·2	·9	·3
15. M1. post.	·9	4·9	1·7	·2	·6	·4

The gap in the measurements of the lower border, opposite the alveoli from the third incisor to the anterior alveolus of the second deciduous molar, is due to the much greater extent of the alveolar than the lower border in that region. As a result of the spreading curvature of the anterior part of the alveolar border in the pig's mandible, the same point on the lower border is " opposite " several alveoli, related to them as the centre of a circle to its circumference. The corresponding alveolar measurements are therefore omitted in the calculation of the percentage increases due to alveolar and lower border growth, so that these may be placed on an equal basis.

Without detailing the rates at which new bone is being added to the lower border, though they are obviously much smaller than at the alveolar border, it will be sufficient to give a table to show the highest, lowest and average percentages which are contributed to the growth in height of the body of the mandible at these two sites. An accurate calculation of the varying rates of growth at these opposite sites in relation to all the alveoli at different ages will require a much larger series of specimens than is yet at my command. The further question of an exact correspondence between rates of growth as so determined and comparative dimensions of jaws of different ages is also complicated by the great variation which is found, both in rates of growth and actual dimen-

sions, in the mandibles of pigs of the same age and from the same litter—a commonplace of observation among breeders, so far as general growth is concerned. It is not yet possible for me to make this comparison, and thus to demonstrate a correspondence and therefore the reliability of my measurements of growth increments, except in a very general way.

The two tables, however, undoubtedly demonstrate, in the first place and on the face of the figures alone without any comment by way of interpretation of the meaning of the actual distribution of the lower border additions, that the alveolar growth is mainly responsible for the increase in height of the body of the mandible.

TABLE II.

The Relative Contributions of Alveolar and Lower Border Growth to the Height of the Body of the Mandible.

	Alveolar Border.			Lower Border.		
Pig No.	Maximum.	Minimum.	Average.	Minimum.	Maximum.	Average.
15	100+?	81·8	92·5	0—?	18·2	7·5
12	100+?	68·8	82·5	0—?	31·2	17·5
2	100+?	70	88·7	0—?	30	11·3

These calculations tell us that the growth of bone at the alveolar border of the pig's mandible from the tenth to the twenty-eighth week is so important for the general increase in the height of its body, that in different regions and at different times it contributes from 70 to 100 per cent. as compared with 0 to 30 per cent. contributed by the lower border, and we must conclude that on the average the alveolar border grows at least seven times as fast.

But that is not the whole story. I have in these calculations taken no account of the reasons for individual variations, and have in fact, loaded the case against the alveolar border by deliberately including No. 12, in which the lower border growth is the greatest in the whole of my series, and excluding others of about the same age in which it is much less. The considerable amount of lower border growth in No. 12 is associated with a marked difference in its contour from that which is found in most others; instead of resting securely on the table on anterior and posterior points, this mandible rides, or rather rode before it was sectioned, on very strong ridges of bone beneath the first molars and immediately in front of the emphasised pre-angular notches. This peculiarity obtruded itself upon my attention when I had to stabilise this mandible before making a projection drawing, a circumstance which led me to seek for an explanation.

The discovery of a reason for the exact distribution of new bone along the lower border of the pig's mandible, and the explanation of the occasional presence of a convexity there instead of the usual concavity, a peculiarity which has its counterpart in the human bone, are so vital for an understanding of the growth of the mandible as a whole, not only in relation to its general form, but also from the point of view of bone mechanics and the possible control of growth, and moreover of such immediate concern in estimating the real extent of alveolar growth, that I must here briefly outline the conception which I have formed as the result of a detailed study

of points which at first sight are of little importance. Much of what is said will apply equally well to the human mandible.

The points upon which the pig's mandible rests, when it is placed on the table, are usually in the vicinity of the symphysis and the rounded angle (Fig. 3). As growth proceeds these points move forwards and backwards respectively by extension to the lower border, and no further, in these regions of the anterior surface and posterior border growth areas. Between these points the lower border as a rule curves upwards, gradually in front behind the symphysis, abruptly behind at the pre-angular notch. Now the position of the pre-angular notch is constant, relative to the lower end of the internal oblique line and the sloping anterior border of the coronoid process. This relative position the pre-angular notch maintains throughout the growth of the jaw, and like innumerable other examples of bone modelling to maintain relative position, it travels backwards by a slight absorption of the newly-formed angle bone, followed by the posterior growing edge of the new bone on the lower border. Behind the symphysis on each side there is likewise a small area of absorption, to which the anterior growing edge of the lower border new bone also extends. The point upon which the jaw rests in front thus travels forwards with its general growth, though to a smaller extent than the backward travel of the posterior point.

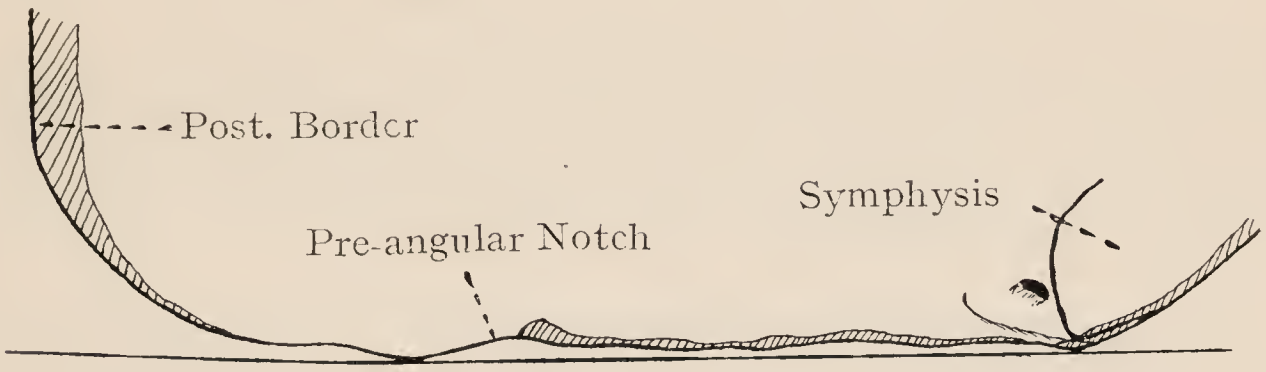

FIG. 3.—Outline of the lower border of the left half of the mandible of a pig to show the points on which it rests and the position of the growing areas. From a pig 24 weeks old, the surface areas covered by new bone being indicated by cross lines. It should be noted that the depth of the lined portions does *not* correspond to the thickness of the new bone added. x $\frac{2}{3}$.

The new bone on the lower border of the mandible, which it should be noted extends on to it from the outer surface, is therefore distributed solely between the anterior and posterior ends of its concavity but reaches neither. Place the mandible on the table and it will be seen that the whole area over which new bone is being added, except at the anterior and posterior points of contact, is above its level. The points upon which the mandible rests therefore travel forwards and backwards, though at different rates, followed by their respective depressions and the advancing edges of the new bone. It follows that the new bone that is seen on the lower border is to a large extent merely reforming its contour by replacing bone which has previously been removed. This is certainly the case behind where the thickest part of the new bone on the lower edge is always found to end abruptly in front of the pre-angular notch, and if the edge be examined from below it is a very striking fact that the lingual edge of the new bone, advancing from the outer surface, crosses the lower border from before backwards in a very oblique and almost spiral curve, so that it merely reaches the lower

border in front but covers it entirely behind (Fig. 4). There is, therefore, as growth proceeds a gradual flattening of the curvature of the lower border of the mandible as the arc lengthens, so that there is always a trifle being added to it for this reason, apart from the backward movement of the pre-angular notch. This amount may in some specimens, as in No. 12 and, as already pointed out, in the " see-saw " type of human mandible, be increased for reasons connected with the general form of the bone and particularly the angle between the ramus and the body, which itself varies with age, but in general we must conclude that the forward and backward growth of the mandible, without addition to its height at either symphysis or angle, is solely responsible for the amount and the peculiar distribution of the new bone on its lower border. It follows that there is no real addition at all from this source to the height of the body.

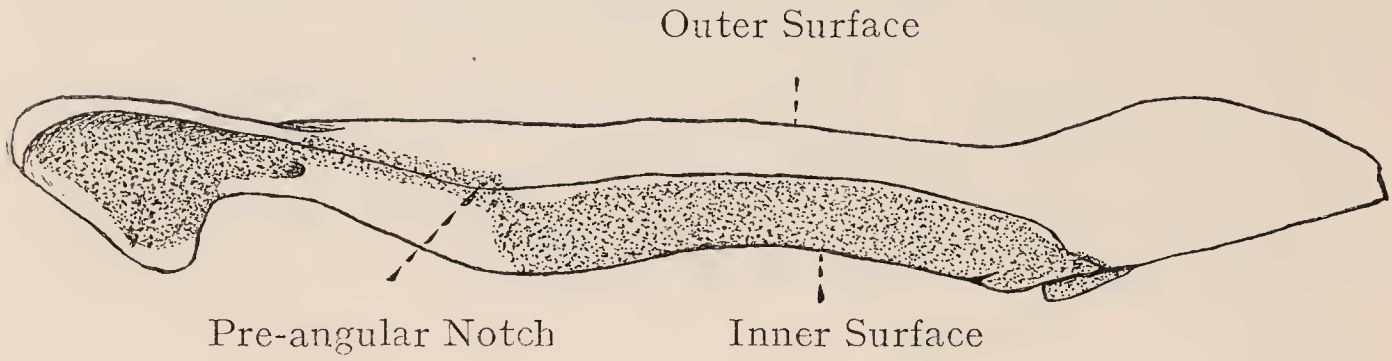

FIG. 4.—The lower border of the right half of the mandible of a pig, 24 weeks old, to show the distribution of new bone and its relation to the growing outer surface. The stippled areas represent old bone, and the white areas new bone laid down during a period of four weeks. Note how the new bone extends from the outer surface to the lower border but ends abruptly in front of the preangular notch. x $\frac{2}{3}$.

Such a conclusion is, of course, opposed to conceptions which have long held the field, but, as I find it increasingly confirmed by numerous details of observation and other lines of argument, I believe that it is true. The backward travel of the pre-angular notch and the lengthening with consequent flattening of the arc of the lower border of the mandible with their relation to the general growth of that bone are, however, beyond the present subject. This is but one of a number of results that have led me to take a new view altogether of that apparently settled question, and I need only say that it will be again carefully considered in greater detail when I deal, as I hope to do at an early date, with the growth of the mandible as a whole.

Meanwhile, if it be true that the lower border takes what is practically no share at all in the growth in height of the body of the mandible, we are compelled to form what is undoubtedly an entirely new conception of the nature and rôle of the alveolar bone. If the whole of the growth in height takes place at the alveolar edge, then it follows that bone originally on this surface becomes incorporated in the basal part of the body, and that the dental canal extends into it. There is, therefore, no essential difference between alveolar bone and the bone of the base, because the former becomes progressively transformed into the latter. We shall see in a moment the comparison that is to be made with the extension of the maxillary canal and the antrum into the maxillary alveolar bone.

Bone Additions to the Maxillary Alveolar Border of the Pig from the Tenth to the Thirty-second Week.

The measurement of additions of new bone to the alveolar border of the maxilla, leading to an increase in its height, is a little more difficult than in the mandible. There are two reasons for this. In the first place, the rate of growth in this direction is not so great, and secondly the downward increment is masked to a considerable extent by the comparatively large outward growth. It is with some reserve, therefore, that I give a series of measurements, although these have been made with as great accuracy as possible after very careful sectioning. These measurements have been taken from the left maxillæ of the same three animals, and although there may be a considerable error of observation, there can be no doubt at all of the general result relative to the amount of growth in the corresponding mandibles. I therefore give them in order to demonstrate that the maxillary alveolar border is also growing downwards as a whole throughout the period covered, and that it does so at a slower rate than the mandibular.

TABLE III.

Growth Increments in the Maxillary Alveolar Border of the Pig.

Sections.	No. 15.	No. 12.	No. 2.
1. i1	1	2·7	1
2. i2	·7	2·3	1·2
3. i3	·5	1·5	·8
4. c	1·3	2·5	1
5. dm1	·7	2·4	·6
6. dm1-2	—	1·9	—
7. dm2. ant.	·5	1·5	·6
8. dm2. post.	·5	1·3	·8
9. dm2-3	·5	—	·7
10. dm3. ant.	·3	1·1	1·3
11. dm3. cent.	·6	1·9	·9
12. dm3. post.	·6	1·5	1·1
13. dm3-4	·2	1·3	—
14. dm4. ant.	—	1·6	·8
15. dm4. cent.	·4	1·3	—
16. dm4. post.	—	1·9	·9
17. dm4-M1	·2	—	·4
18. M1. ant.	—	3·9	·7
19. M1. cent.	—	4·4	—
20. M1. post.	—	3·9	·9

The same remark as in the case of the mandibular series is to be made on the general distribution of the growth; the maximum is in the anterior region, leading as in the mandible to forward extension of the jaw by addition to its edge in the direction in which it points; and there is again an increase in the region of the first permanent molar in No. 12 on account of the state of eruption of that tooth.

Calculation of the rates at which the alveolar bone is growing in different regions shows that the minimum is ·1 mm., the maximum

1·1 mm. and the average in these three pigs ·37 mm. per week. These figures, compared with the corresponding rates for the mandibles of the same animals show that the same process is at work at something less than half the rate.

As I have already indicated, these observations of the downward growth of the maxillary alveolar border are complicated to a greater extent than in the mandible by outward growth and the consequent labial changes in the position of the teeth. This point I shall refer to again in considering labial movements; in the meantime we may take it as certain that there is a steady downward growth of the maxillary border.

The Relation Between the Growth of the Alveolar and the Sutural Borders of the Maxilla in the Pig.

It now becomes of importance to turn to the other, articulated, margin of the maxilla to see if we can detect growth there and the amount of it, and to institute a comparison with the lower border growth of the mandible. I confess that the difficulties of observation on this point are at first sight very great, on account of the complicated articulations of the maxilla in the pig. It is, indeed, apparently quite clear in the skull as a whole that the upper border, articulating with the premaxilla, nasal and frontal in front, the lachrymal and the malar behind, is a growing edge; separate the bone however from those with which it articulates, and the appearance of the suture surface is such that it becomes a question whether the true process that is at work is not a reformation of the edge and of the sutures themselves as the facial bones expand by surface additions (Fig. 5, *a* and *b*). The fact that the surface of the maxilla itself is being excavated by absorption below the line of its sutures is also to be taken into account. This surface travels backwards by bone addition inside and absorption outside in general conformity with the lengthening of the face and the backward travel of the malar process as the molar teeth erupt; it is more than probable that there is a corresponding movement of the sutures which unite the maxilla to other bones.

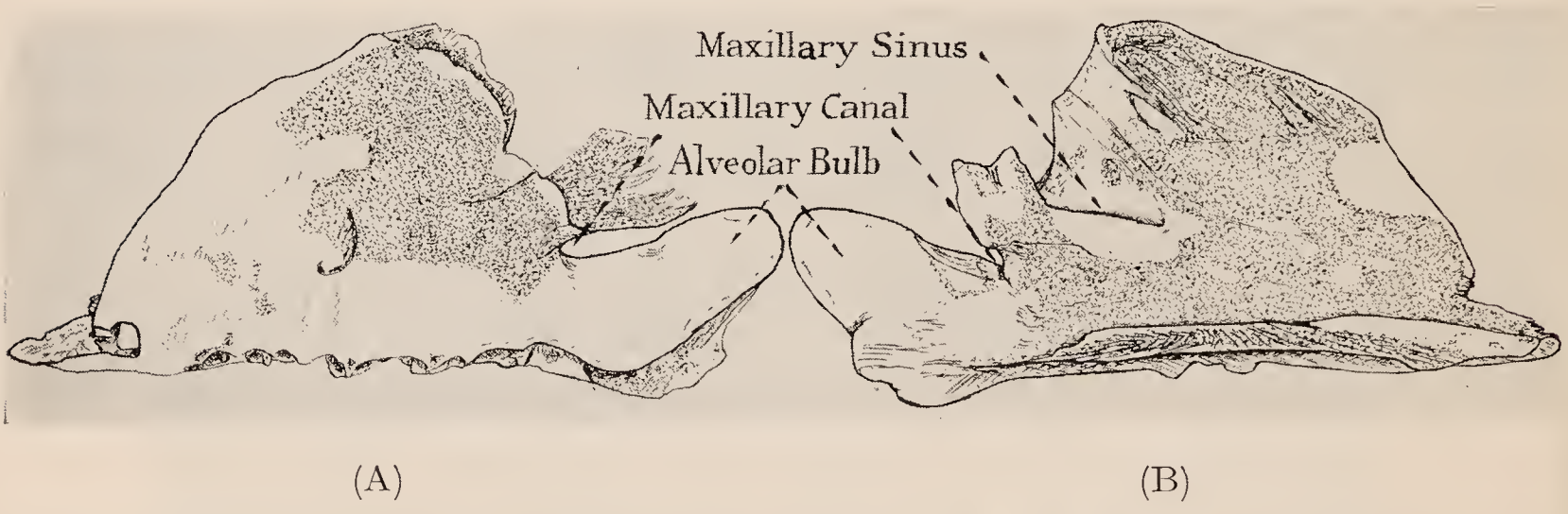

Fig. 5.—The left maxilla of a pig 32 weeks old, (A) outer, (B) inner surface. To indicate the method by which the facial surface and the maxillary sinus move backwards by external absorption and internal deposit of bone, and the corresponding upward and backward movement of the sutural border upon other bones without any downward translation of the maxilla as a result. The stippled areas represent old bone, and the white areas new bone laid down during a period of four weeks. Points in the structure of the bone are also to be observed. *Cf.* Figs. 2, 6 and 7. x $\frac{1}{2}$.

Here we enter the difficult and debatable ground of the relation of sutures in the skull generally to the growth of the individual bones and of the skull as a whole. This I cannot discuss at present, but the position to which the evidence of madder specimens is slowly bringing me is this—that growth at sutures, in the sense of separating bones which remain in the same plane, does not in fact take place at all; what appears to be separating growth is in reality a movement of the sutures by growth changes of bone deposit and bone absorption on opposite sides of the surfaces through which they pass. In this way the edge of one bone may change its position in relation to the surface of another without any separation of the bones as a result.

The articulated margin of the maxilla in the pig is, I believe, an example of this process, and although these suggestions are put forward at present in quite a tentative way, the conclusions to which they lead—that growth at the articulated margin of the maxilla results merely in an upward travel of that margin upon the bones with which it is in contact and not at all in any downward movement of the maxilla as a whole in relation to the other bones of the skull, and that the growing alveolar border is responsible for the real increase in the height of the maxilla—these conclusions are quite in conformity not only with the evidence from sutures in other parts of the skull, but also with what I believe to be the general principle of skull growth—expansion by deposit on free surfaces only.

This whole question will in due course be the subject of another publication; in the meantime the point is that the alveolar border being a part of the free surface of the maxilla, the growth additions to it are responsible to a very great extent, if not solely, for the increase in height of the body of the bone. The agreement with the conclusion already reached for the body of the mandible is obvious, and the two sets of observations, if they stand the test of discussion and of further evidence, throw into prominence the fundamental importance of the activities of the alveolar bone.

We turn for a part of that further evidence to the floor of the maxillary canal, to the plate of bone which separates it from the overlying maxillary sinus, and to the outer part of the floor of the sinus itself. In the period which my specimens cover, the maxillary canal immediately overlies the inner part of the alveolar border from the second deciduous molar backwards, while the outer part of a smaller extent of the same portion of the border lies directly beneath the sinus. We find in the first place that a broad thin sheet of new bone is being laid down on the inner aspect of the anterior part of the floor of the sinus, extending on to its lateral wall, but that the position of the new bone at the back of the sinus is reversed since it is on the outer side of the wall that it is found (Fig. 7).

It is clear from the distribution of the new bone that the sinus as a whole is travelling backwards in conformity with the changes already referred to, which affect the anterior surface and malar process of the maxilla, and with the backward growth of the hinder end of the alveolar border itself. In the middle and outer part of the floor of the sinus, however, active absorption is proceeding, and it is equally clear that, as the sinus is being remodelled in the backward direction, it is also deepening at the expense of the alveolar border.

The floor of the maxillary canal has the same tale to tell (Fig. 6). In the anterior part, according to the age of the animal, there are elevations covered by new bone laid down as the underlying crypts of the premolars expand in this direction; but behind these, and continuing right on to the base of the alveolar bulb, there is again active absorption, so that in the course of three to four weeks the canal has extended right into the new bone which has meanwhile been forming in the lingual alveoli of the underlying molars, as is also the case in some specimens with the floor of the sinus itself and the buccal alveoli of the same teeth.

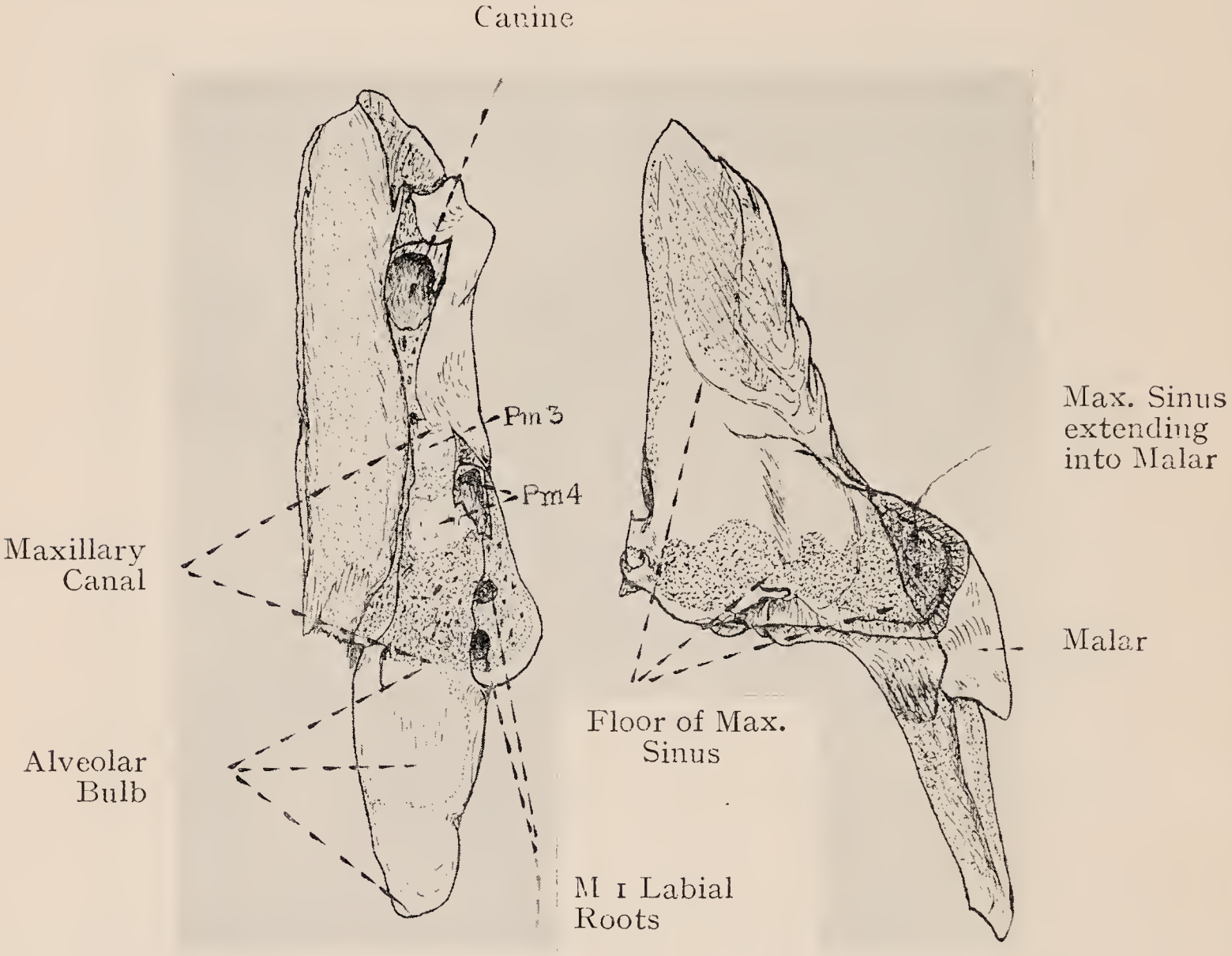

Fig. 6 Fig. 7

FIG. 6.—Upper surface of the lower half of the right maxilla of a pig, 28 weeks old, divided by a horizontal cut passing through the maxillary canal. The floor of the canal is exposed from the "infraorbital" foramen in front to the alveolar bulb behind. To illustrate the account in the text of the extension downwards of the maxillary canal into the alveolar bone. The stippled areas represent old bone, and the white areas new bone laid down during a period of four weeks. x $\frac{2}{3}$.

FIG. 7.—The upper surface of the upper half of the same maxilla. To illustrate the backward movement of the maxillary sinus and the extension downwards into the alveolar bone of the lateral part of its floor. The stippled areas represent old bone, and the white areas new bone laid down during a period of four weeks. The new bone in the floor of the sinus is being added on its inner aspect in front but on its outer aspect behind. x $\frac{2}{3}$.

Here then is confirmatory evidence of the conclusion that the alveolar is the growing edge of the maxilla as of the mandible: in the maxilla also the deduction is to be made that there is no real distinction between alveolar and other bone; as the process

which we have outlined proceeds, bone which was formerly on the edge of the alveolar border becomes incorporated in the walls of the maxillary canal and sinus, strengthened by interstitial deposit into compact bone to take its share in the support of the alveolar bone which has succeeded it.

Here I would again refer to the fœtal and adult positions of the maxillary nerve in relation to the alveolar bone in the human skull as part of the evidence that the same process exactly is at work in the growth of the human maxilla. The increase in height of the human maxilla, greater in proportion than in the maxilla of the pig, can only be by the growth of its alveolar border followed by the excavation of the antrum, which in the end widely separates the nerve from the alveolar bone with which in the beginning it was in the closest contact.

As further confirmatory evidence of the conclusions thus briefly outlined, I would also once more call attention to the process, now, I believe, well-recognised, by which the hard palate, relative in its position like everything else, descends by addition below and absorption above in conformity with the growth of the alveolar border. The height of the palate and its relation to the floor of the antrum at any given period are but an expression of the relative rates at which the growth of the alveolar border, the excavation of the floor of the antrum and the growth descent of the palate itself have been proceeding.

To sum up this part of the paper it may be said that the growth of the alveolar bone is of the greatest, possibly of sole, importance for the general increase in height of both the mandible and the maxilla. In the pig it is in this respect relatively more important in the mandible than in the maxilla, since the chief growth directions in the face are forwards and backwards to elongate the snout. In the human skull, on the other hand, the relative importance is almost certainly reversed, since here the chief growth direction is downwards. This conception agrees with the observed facts in the human skull of the developing relation of the alveolar bone to the orbit and the extension of the antrum between them.

The Growth of Alveolar Bone in Relation to Movements of the Teeth.*

Having now reached an important conclusion regarding the constant growth of the alveolar bone, it is with added interest that we turn to the question of what happens to the teeth. If the alveolar bone grows and continues to grow in the manner I have described, the teeth which it contains and supports must necessarily be constantly moving with it, or else the fate of all would be the reverse of what happens to the molars as they emerge from the root of the coronoid in the mandible—they would be reburied in the bone from which in eruption they had previously emerged. Yet for the most part, once and so long as teeth are in position, they appear to undergo very little change in relation to the bone which supports them. Hence the tenaciously held opinions regarding the cause of the similarity of the deciduous and permanent alveolar arches.

To quote Sir Charles Tomes' summing up of Sir John Tomes' original account: "In the region of the jaws occupied by the twenty temporary teeth very little growth or change subsequently

* Sir Arthur Keith was the first to point out the significance of the relation of alveolar bone growth to movements of the teeth, with particular reference to their eruption. *Vide* Ref. No. 4.

takes place, so that it comes to pass that the incisors, canines and bicuspids ultimately occupy an arch which hardly differs either in size or shape from that occupied by their predecessors. . . . If, then, in the treatment of irregularities, whether threatened or accomplished, we expect improvement due to growth in this anterior region of the mouth, we shall be disappointed; yet how seldom, if we read the lengthy and involved dissertations which from time to time appear upon this subject, is this fundamental truth fully grasped. It may be thought that this point about the very small growth of that portion of the jaws occupied by the temporary teeth had been already proved *ad nauseam*, and that anything more was superfluous. But . . ."

But . . . the fundamental truth about the growth of the skull is the difference between appearance and reality. We can believe that the teeth are the same, but that the arches also appear to be the same, even if there were not differences that can be measured, is no proof that they have not altered. Growth in the region occupied by the twenty temporary teeth there undoubtedly is, though whether it may of itself produce improvement of irregularities or, when its nature is an open book, be guided in so doing, is another question. Relativity is again the watchword, and the movements of the teeth in the alveolar border, to which we now proceed, are but another example of the process which we are learning to regard as universal in the growth of bones—the maintenance or the alteration (by the processes of deposit and absorption) as function demands, of the relative position of different points.

Now there are three possible directions in which the teeth may move in the alveolar bone.

(1) In a vertical plane, upwards or downwards in the line of their own long axis.

(2) In the horizontal plane at right angles to the plane of the alveolar border, i.e. outwards or inwards in a bucco-lingual line.

(3) In the horizontal plane parallel to the plane of the alveolar border, i.e. forwards or backwards in a proximo-distal line.

I may say at once that evidence is now available to demonstrate normal movements of the teeth, both fully erupted and erupting, in all three directions during the growth of the jaws.

Movements of the Teeth in the Vertical Direction in the Growing Alveolar Border.

If there be a continuous uninterrupted growth of the alveolar bone all along its edge, so that, irrespective of temporary local absorptions as teeth erupt, its actual surface is constantly being added to, it follows that there must be a general movement of the teeth upward in the border, if they are to maintain their relation to the surface. This continuous upward movement of the whole row of teeth does in fact take place. The movement, of course, is not all in the same plane, but the actual direction of the movement of any particular tooth depends upon the inclination of the part of the alveolar border in which it happens to be set. In the jaws of the pig, for example, the teeth in the premolar region rise more or less vertically, whereas the incisors and canines move in the oblique direction of the part of the alveolar border in which they are set. The front part of the border in the mandible is very oblique, and growth in that region results in large additions to the length of the mandible; the incisors move forwards a corresponding amount to maintain their level.

Turning to the observed facts of bone growth in relation to this general movement upwards, it may be said that in general new bone is added to the walls of the alveoli and to the inter-alveolar septa in amount corresponding to the growth of the edge—the amount added in the alveoli being sufficient to narrow the lower part and fill up the apex as the tooth rises into the newly formed upper part. In this way it is clear that the alveolus even of a fully erupted and apparently stationary tooth is constantly altering so that in due time it is entirely new (Fig. 8 and Plates III and IV).

FIG. 8.—To illustrate the distribution of new bone associated with upward movement of the teeth in different situations. Sections of the left mandible and maxilla of a pig 20 weeks old. The stippled areas represent old bone, and the white areas new bone laid down during a period of four weeks. (A) Alveolus of mandibular central milk incisor with crypt of permanent tooth behind; (B) distal alveolus of mandibular third milk molar; (C) distal alveolus of maxillary second milk molar; (D) distal alveolus of maxillary first milk molar. x $\frac{1}{2}$.

But we must not expect to find on looking into the alveoli in our madder specimens that their inner walls are entirely formed of new bone. The details of the additions to these inner walls vary from tooth to tooth, in the first place according to the obliquity of their implantation in the border, and also in conformity with the different combinations of movements in the other two directions. The effect of oblique implantation upon the distribution of the new bone in the alveoli is best illustrated by a simple diagram of the bone changes in the alveoli of a double-rooted tooth which is rising vertically in a growing border (Fig. 9). It is clear that the apex of the interalveolar septum will itself rise vertically, and that new bone will be deposited on both sides of the septum, whereas the anterior and posterior walls of the anterior and posterior alveoli respectively will be the seat of absorption, involving necessarily a small portion of the new bone of their edges even as it is laid down. It is indeed a little difficult to find a pure example of such a distribution of new bone because of the constantly associated movement of the teeth in two other directions; nevertheless such examples are to be found. In this connection I may be allowed to quote a passage from the first

of my lectures in the 1924 Dental Board series. Discussing shortly the question of possible movements of the teeth forwards in the alveolar border, I then said " that my madder specimens provide no unequivocal evidence of such a movement of the molars in a forward direction in the alveolar border. The general growth of the alveolar border includes, as we have seen, the addition of new bone not only on the free surface, but also on the inner surface of all the tooth sockets; this is associated with the raising of the teeth as the border itself rises. If it were clearly the case that the bone addition to the posterior walls of the sockets is greater than to the anterior walls, this would be evidence of a forward as well as an upward movement of the teeth; no such evidence is forthcoming. In sagittal sections of individual alveoli I have indeed observed a greater amount of new bone on the posterior wall, but in others it is on the anterior wall that the greater amount appears." Here is the simple explanation of these observations recorded at the time in diagrams, which I refrained from publishing as I had not grasped their true significance.

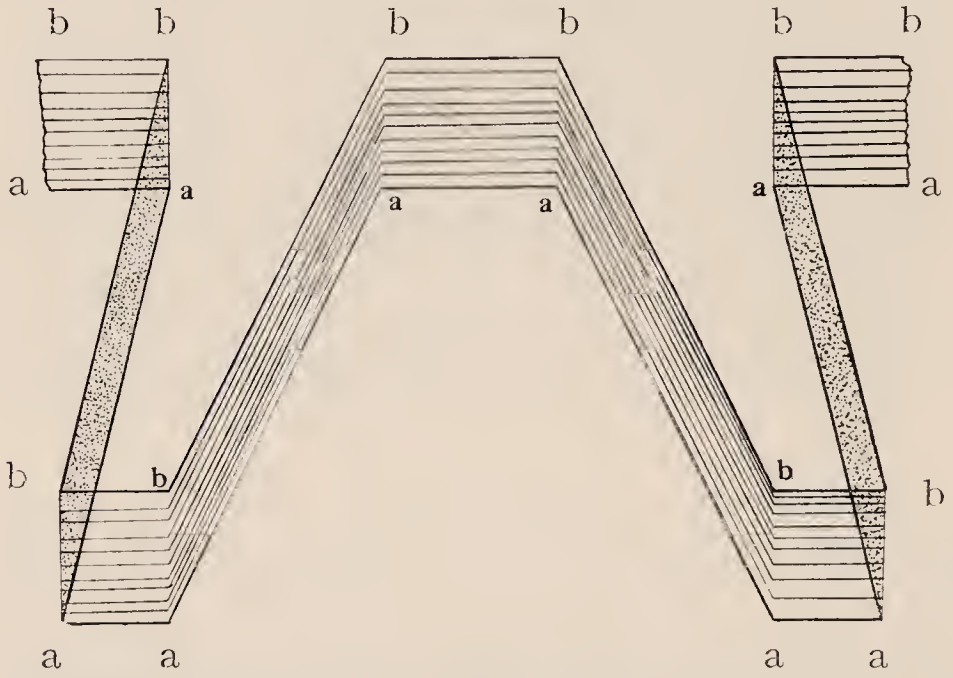

FIG. 9.—Diagram of the sites of bone deposit and absorption associated with the vertical rise of a tooth with double obliquely separated roots. a-a-a and b-b-b, original and new surfaces of alveolar border and alveoli. The sites of deposit of new bone and the successive positions of the new surfaces are indicated by the series of parallel lines, and the sites of absorption by stippling. It will be noticed that bone deposit and absorption overlap at two places; at the alveolar edge deposit is followed by absorption, at the alveolar apices absorption is followed by deposit. This diagram applies equally well to the changes in the proximal and distal alveoli of a mandibular tooth or the lingual and buccal alveoli of a maxillary tooth. *Cf.* Figs. 19, 20 and 21.

Apart from variations in the distribution of new bone on the walls of the alveoli, which find their explanation in the other two movements which the teeth constantly undergo, vertical movement then is indicated by the filling of the socket below and its reformation at the surface. In the case of teeth with more than one root, the amount added to the edge of the interalveolar septa corresponds almost exactly to the growth of the edges; whatever the cause of the rise of the teeth, and let us remember that we are speaking now of the upward movement of fully erupted teeth without additions to the length of their roots, the bone growth is found in exact correspondence with it. Since this bone growth is only part of the general growth of the jaw, it is hard to resist the conclusion that we are dealing here, as I have said, with another

example of maintenance of relative position by bone growth and bone absorption, and that in fact the growth of the alveolar border, with additions to interalveolar septa and the filling of the alveoli from below, is actually responsible for the movement of the teeth.

To sum up conclusions with regard to the vertical movement of the teeth, it may be said that during the period of growth the whole row of completely erupted teeth is constantly rising in the growing alveolar border. Movement of this nature in a straight border maintains the teeth in the same relation to each other and apparently in the same relation to the border itself, but in a curved border the circumference must gradually increase and the spaces between the teeth with it. This actually happens to a very considerable extent in the anterior part of the pig's jaws, and it is most probably partly responsible also for the observed separation of the human milk teeth.

Vertical Movement of the Teeth During their Eruption.

The vertical movements which we have been discussing are those observed in the case of fully erupted teeth; they are movements which, in the absence of knowledge of the constant growth of the alveolar border, may completely escape our notice. Having satisfied ourselves in the light of that knowledge that these constant vertical movements of fully erupted teeth do in fact take place, the next question that at once presents itself for consideration is the relation of the hidden movement of erupted teeth to the manifest movement of erupting.

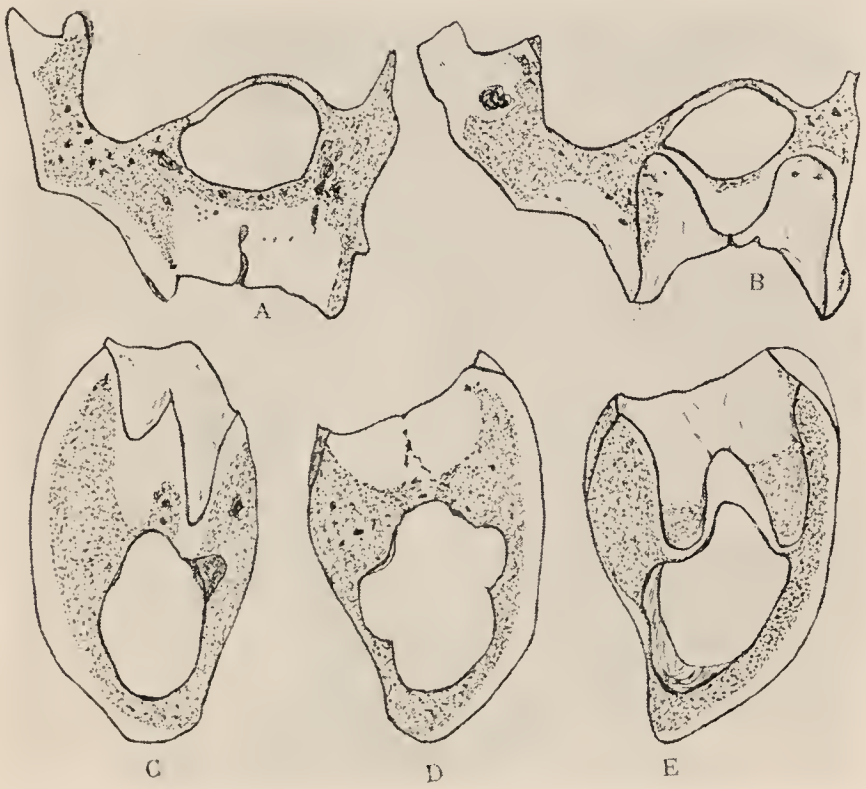

Fig. 10.—Series of sections of maxillary and mandibular alveoli of left first permanent molars to illustrate the deposit of new bone associated with the eruption of that tooth. From a pig 20 weeks old; the stippled areas represent old bone, the white areas new bone laid down during a period of four weeks. (A) Distal view of section through interalveolar septum of maxillary M1; (B) proximal surface of distal alveolus, maxillary M1; (C) proximal surface of proximal alveolus, mandibular M1; (D) proximal view of section through interalveolar septum of mandibular M1; (E) distal surface of distal alveolus, mandibular M1; in (A) and (B) the relation of the alveoli to the overlying maxillary canal and sinus is shown. *Cf.* Fig. 2. x ½.

I am not yet in a position to give a completely detailed account of the relation of bone growth to all the stages of the eruption

of all the teeth in the pig, but if we consider the eruption of the third permanent incisor and the first permanent molar, which are most fully represented in the period which my specimens cover, we are provided with examples of the eruption of teeth, single and multi-rooted, with and without deciduous predecessors.

Now if we examine madder specimens of all stages in the eruption of the first permanent molar, we observe in the first place that the bone growth in a vertical direction, which from the nature of the case we know must be taking place, is in its general distribution similar to the bone growth which is simultaneously raising the fully erupted fourth milk molar in front of it (Plates III and IV and Fig. 10). The bone growth is the same although the roots of the former are growing throughout the period, whereas the roots of the latter have already attained, or attain during the period, their maximum length, or in the later stages may be undergoing absorption in relation to the underlying sac of its permanent successor. After the preliminary absorption of the alveolar edge to allow the passage of the tooth, there are additions to the edge itself, to the interalveolar septa and on the walls of the individual alveoli, all similar to those I have described for the fully erupted tooth, only in greater amount. While the amount of the new bone is always greater in the vertical direction, it will, however, be readily understood that each alveolus has its own individual variations in its distribution, corresponding to the other movements which take place during eruption, including movements of rotation which the molars undergo. At the same time there is addition to the length of the roots of the tooth, an elongation which is not only obvious from their increasing length, but which can also be exactly measured since dentine shares with bone the madder staining.

Now the arguments against root elongation as a "cause" of eruption are familiar to every dental student, and it has long been known that the distance travelled by the crown of an erupting tooth may be considerably greater than the increase in the length of its roots during the same time. But the exact relation of the growing root to the bottom of the alveolus has never been determined, and could not be determined so long as the growth direction of the bottom of the alveolus and the extent of the movement of the tooth itself relative to the moving surface of the alveolar border were unknown. The madder method enables us to make this comparison, and I therefore give here data from the same three pigs as before to demonstrate this relation at different stages of the eruption of the first permanent molar.

TABLE IV.

The Relation of Increments of Molar Roots and Alveolar Growth during the same Period.

Pig. No.	Root Growth. Left First Molars.		Alveolar Growth. Interalveolar Septum.	
	Lower.	Upper.	Lower.	Upper.
15	1·5	1·7	1·9	Slight
12	4·6	4·1	4·9	4·4
2	1·6	1·3	·8	·8

THE GROWTH OF THE ALVEOLAR BONE AND ITS RELATION TO THE MOVEMENTS OF THE TEETH, INCLUDING ERUPTION.

By James C. Brash, M.C., M.A., M.D.,
Professor of Anatomy, University of Birmingham.

It will be observed from these figures that in Nos. 15 and 12, aged 13 and 20 weeks with increments representing two and four weeks' growth respectively, the increase in length of the roots is slightly less than the corresponding growth upwards of the inter-alveolar septum. The upper molar of No. 15 is an exception to this statement, but it completes this short series in that it represents an earlier stage when the tooth is not yet closely embraced by the walls of the crypt as these become transformed into alveoli; in this particular tooth the roots are just beginning to join each other; their growth and the growth of the floor of the crypt have not yet been sufficient to bring them into contact. With this exception, it follows that the distances travelled by the crowns of these teeth have been slightly greater than the lengthening of their roots during the same periods.

No. 2, on the other hand, 28 weeks old and towards the end of the period of eruption of the first permanent molars, shows the opposite condition, the elongation of the roots during the four weeks' growth represented by the increments being about twice

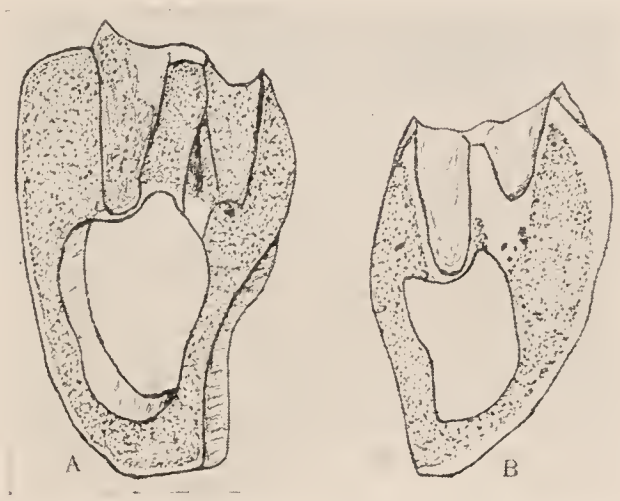

Fig. 11.—Sections of the alveoli of mandibular first permanent molars to illustrate the different directions of apical bone growth at different stages of eruption. The stippled areas represent old bone, the white areas new bone laid down during periods of four weeks. (A) Proximal surface of distal alveolus of mandibular M1, from a pig 28 weeks old; (B) distal surface of proximal alveolus of mandibular M1, from a pig 20 weeks old. In (B) the vertical rise of the tooth is proceeding faster than the growth of the root, and the new bone is being laid down on the inner side of the apex of the alveolus and is continuous with new bone on its lingual wall; in (A) the growth of the root is proceeding faster than the vertical rise of the tooth, and the new bone is being laid down on the mandibular canal side. x $\frac{1}{2}$.

as great as the distance travelled by the crown during the same period. It follows that in the first two the apices of the alveoli should be travelling towards the surface by deposition of bone from within, though relatively the alveolus appears to deepen since the surface itself is travelling faster, and in the third that the reverse should be happening—an excavation of the apices from within to receive the increment of the roots. An examination of the alveoli in section demonstrates that the position of the new bone is in exact correspondence with these deductions, the apices of the alveoli in Nos. 15 and 12 showing a layer of new white bone, while the apices of the alveoli in No. 2 on the other hand are red with signs of absorption (Fig. 11). On turning to the points where these apices approach the mandibular and maxillary canals it is at once obvious that as the roots grow down into the bone they are beginning to appear in these cavities, but separated from them by tiny caps of new bone formed on that side. It is the usual combination of the two processes; absorption makes way for these roots, and on the cavity side new bone is added which prevents them from penetrating it.

This is the terminal stage in the relation established between tooth and bone by the process of eruption. Owing to the rapidity with which the tooth is raised, the growth of the roots is for the greater part of the time less than the distance travelled by the crown. Towards the end, however, with the slackening of the rate of bone growth towards the average of the alveolar border, the growth of the roots becomes relatively greater so that the process at work is reversed in the depths of the alveoli. Thereafter the rise of the tooth is at the rate of the general growth of the alveolar border, and as the roots attain their final length, they begin again to draw away from the apices of the alveoli; these are again filled up by new bone deposited from within, followed in turn by the excavation of the maxillary and mandibular canals. For some time the relation thus established between the apices of the teeth and these canals is maintained by the same process, but as the jaws of the pig increase in size, and especially in the mandible as the tusks grow backwards, alveolar growth outstrips expansion of the canals, and the roots once more become separated, in the mandible to a comparatively great distance, from the cavities.

There can be little doubt that the appearance of the roots of the molars projecting into the maxillary antrum, as they often do in the human skull, is brought about by the combined process of downward excavation of the antrum and, in the later stages, upward growth of the roots in the manner observed in the jaws of the pig. All the variations in the matter of the relation established by the roots of the teeth—molars, premolars and canine—to the antrum are certainly due to this combination, though the variable extent and direction of the expansion of the antrum is mainly responsible.

To sum up the conclusions to which observation of the process of bone growth in relation to the eruption of the first permanent molar in the pig inevitably leads, it may be said that the phenomena observed in the continual rise of the fully erupted fourth milk molar and in the more rapid rise of the erupting permanent molar behind it are exactly of the same nature. The cause of the rise of the permanent molar in eruption must be the same as the cause

of the continued rise of the erupted milk molar, and in succession of the permanent tooth itself behind it after eruption is complete. Bone growth is the common and the decisive factor.

It is hardly necessary for the main purpose of the present paper to detail here the similar evidence that is forthcoming from a study of the stages in the eruption of the third permanent incisor. It is sufficient to say that in the eruption of a single-rooted tooth there is the same comparison to be made with a fully erupted tooth rising in the growing border. In both there is the same growth of new bone, separated from fully-erupted by alveolo-dental periosteum, but from the erupting at first by the tissues of the tooth-sac. As the tooth increases in size and begins to approach the surface, these are reduced to the alveolo-dental periosteum as the bone

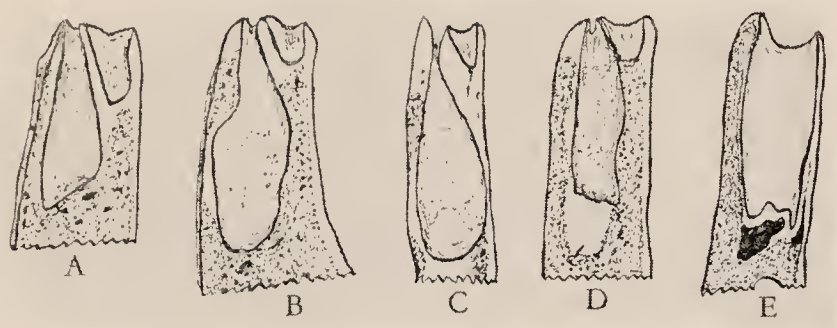

FIG. 12.—Series of sections of the crypt and alveolus of the third permanent mandibular incisor to illustrate the sites of new bone deposit during the eruption of that tooth. The stippled areas represent old bone, and the white areas new bone laid down during various periods. (A) From a pig 13 weeks old, 2 weeks' growth ; (B) from a pig 18 weeks old, 3 weeks' growth ; (C) from a pig 20 weeks old, 4 weeks' growth ; (D) from a pig 24 weeks old, 4 weeks' growth; (E) from a pig 28 weeks' old, 4 weeks' growth. The upward and labial movement of the crypt and the socket is indicated by the distribution of the new bone, with consequent extrusion of the deciduous tooth on the lingual side. x $\frac{1}{2}$.

simultaneously closes upon it to transform the flask-like crypt into the narrower socket (Fig 12).

A further note will be made on the eruption of successional teeth after the discussion of labial and proximal movements. We shall then be in a position to consider the relation of the expanding crypts to the movements of the deciduous teeth, to define more precisely what we mean by "eruption," and to view the process in better perspective than has hitherto been possible without a knowledge of the constant movements of all the teeth.

THE GROWTH OF CEMENTUM AS A FACTOR IN THE VERTICAL MOVEMENTS OF THE TEETH.

Before leaving the question of vertical movements of the teeth a remark must be made on the part played by the actual increase in the thickness of the roots of the teeth themselves, and of the under aspect of the crowns of those with more than one root, by the growth of cementum. During eruption, and to a lesser extent in the fully-erupted tooth, cementum thickens by surface deposit. This is a true bone growth, so that the term "alveolo-dental periosteum" is preferable to "alveolar membrane"; the articulation of the tooth is therefore a true synarthrosis—the gomphosis or peg-like joint.

The growth of cementum can be demonstrated by the madder method, and its addition to the surface during a non-madder period is partly responsible for the apparent fading towards the crown

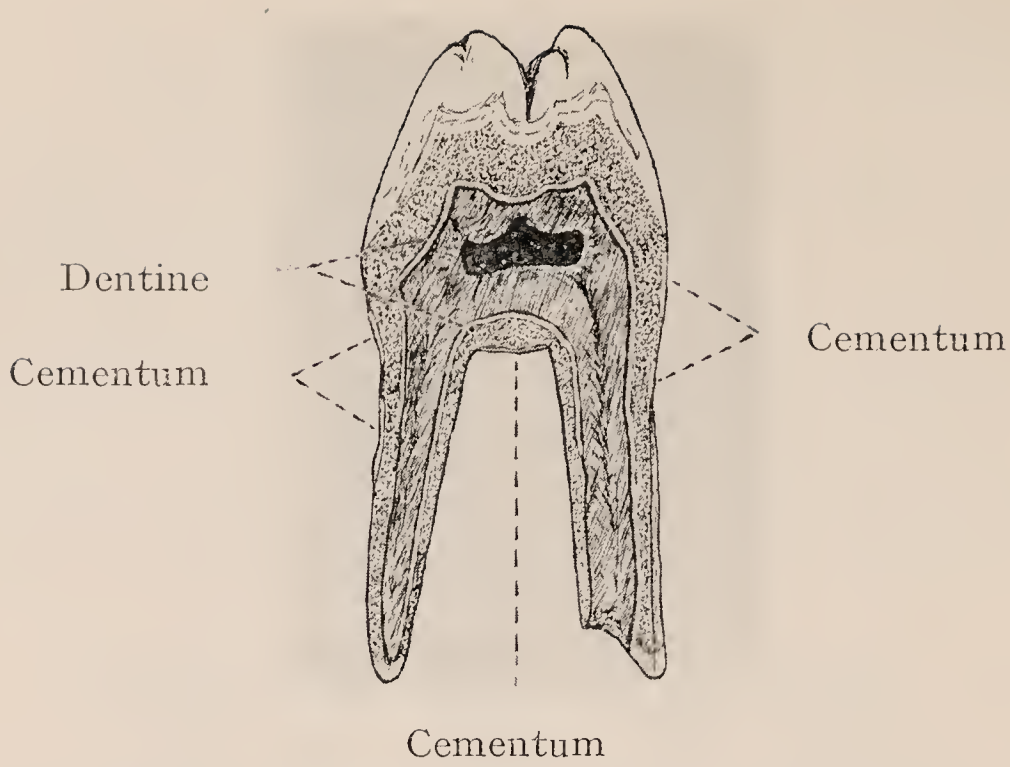

FIG. 13.—Section through the distal roots of the left mandibular first permanent molar of a pig 28 weeks old. The stippled area represents old dentine and cementum, the narrow white area lining the pulp chamber new dentine laid down during four weeks' growth, and the patches of white on the outer surface of the roots the addition of new cementum. The cementum patches are exceedingly thin and are proportionately much too thick in the drawing. The growth of the apices of the roots is also represented. x $\frac{2}{3}$.

of the red dentine of the roots of the teeth. Section of a growing root demonstrates the true state of affairs, as the red centre is then seen to be covered by a thin white layer on both surfaces, due on the pulp side to the addition of dentine, on the outer of cementum (Fig. 13).

Growth of cementum proceeds throughout the life of the tooth, and there can be little doubt that its increase is a contributory factor in the movement of the teeth vertically in the alveolar border both during and after eruption. I am unable at present to measure or estimate this factor, but it is probable, however slight it may be, that its importance relative to alveolar bone growth alters a little progressively with growth. During rapid growth of the jaws there can hardly be said to be any comparison at all, but probably cementum additions gradually acquire a greater rôle. There ought, if cementum additions have any measurable effect, to be a slight discrepancy between observed additions to alveolar bone and the actual vertical movement of the tooth, but this discrepancy must be so small as to be within the error of observation. Moreover, the effect of cementum growth is discounted and possibly neutralised altogether by a progressive diminution in the thickness of the alveolo-dental periosteum, but I have no data on which to come to a conclusion on this small point.

There may, however, be conditions under which cementum growth increases in importance, so that it may perhaps take the place altogether of alveolar bone growth. In the gradual extrusion, for example, of fully-erupted teeth from their sockets, if for any reason they be unopposed, it is possible that a thickening cementum plays an important part, but in the absence of exact information regarding its progressive increase and the distribution of alveolar new bone in such cases, this must remain a speculation only. Certainly the apices of the alveoli will fill up as the tooth rises,

though if the process proceed to the point of actual extrusion of the tooth, this will merge into the subsequent absorption of the bone.

The Continued Movement in the Alveolar Bone of Persistently Growing Teeth.

Another question that suggests itself in this connection, and with reference to the whole problem of the eruption of teeth and their continued movement in the alveolar bone, is the as yet undiscovered cause of the constant forward movement in the bone of teeth growing from persistent pulps. This cannot be due to the growth of the pulp itself, since that is efficiently protected from pressure, as for example in the incisors of rodents, by the invariable curvature of such teeth. During the earlier stages also, before eruption and during eruption and even for some time after the tooth comes into use, the rapid growth of the root leads to its movement backwards by associated absorption and reformation of its alveolus, in the manner described for the inward growth of the roots of the molars in the last stage of their eruption, so that the growing ends of the mandibular incisors ultimately come to lie behind the root of the coronoid. This process I have observed in the growth of the incisors of the rat by means of the madder method.

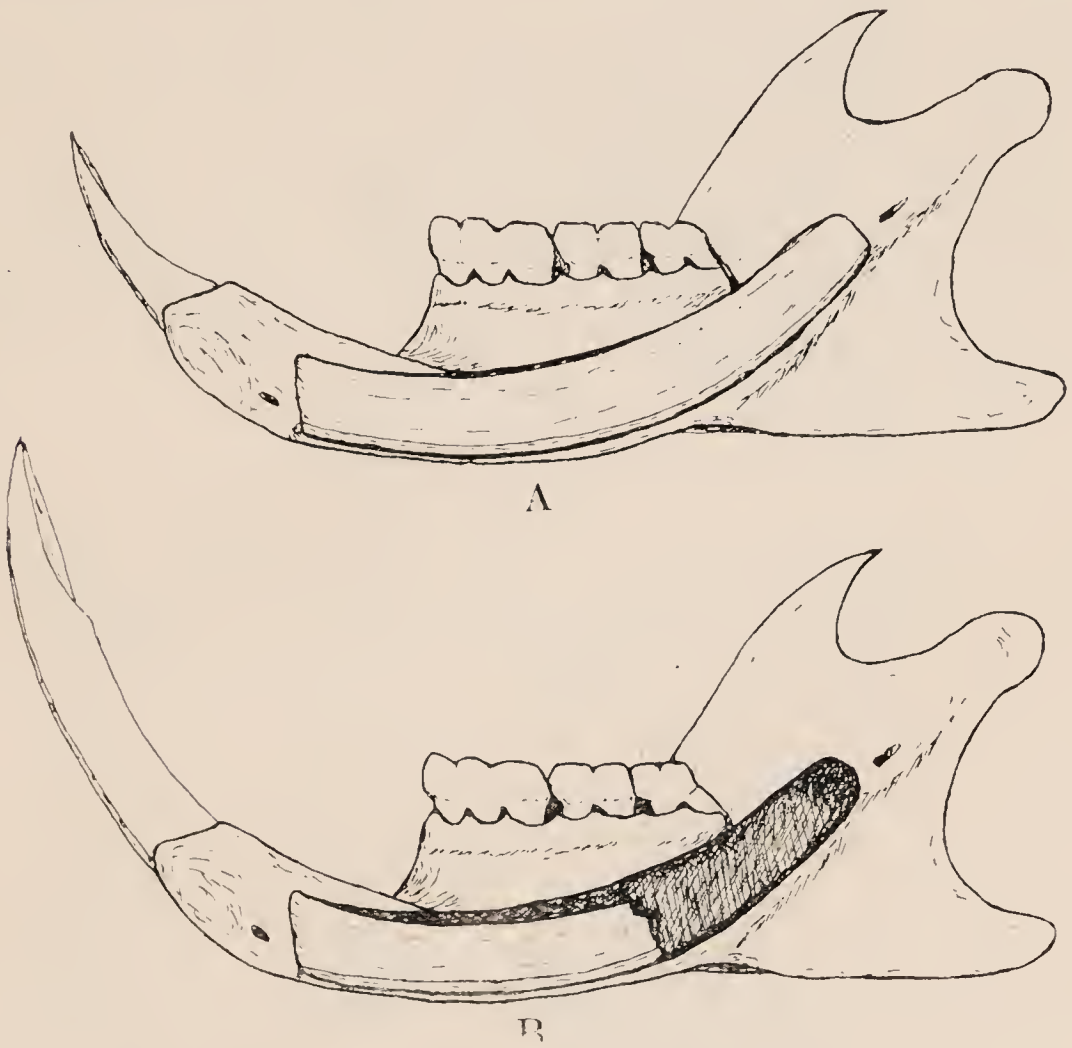

Fig. 14.—The lingual aspect of the right half of the mandible of a rat (No. 61A) 18 weeks old. The lingual wall of the incisor socket has been removed to show the position of the tooth. (A) The tooth is in its natural position, occupying the whole of the socket with the apex of the root, owing to the slight spiral twist, turned outwards to occupy a slight elevation on the lateral aspect of the mandible just below the coronoid; (B) the tooth is partially extruded from the socket to show that the root does not occupy the whole diameter of the middle part of the socket. The slight apparent diminution of the diameter of the extruded portion of the tooth is due to the rotation consequent on the spiral curvature. x 3.

Nor can the continued movement be due to bone additions to the alveolar walls after the growth of the jaw is complete. This I believe to be the immediate cause of the movement of these teeth, as of any others, during eruption and probably a little longer, but a continuation of the same process after the growth of the jaw has ceased would inevitably lead, since the alveoli then become stationary, to their filling up and an arrest of the movement.

But the teeth themselves continue to move forwards, and as they move they carry with them the constant additions to their enamel and cement which they receive from the persistent enamel organ and the alveolo-dental periosteum. On the analogy of the cement factor in the rise of erupting and erupted teeth of limited growth, and by a process of exclusion, I conclude, or should I say I hazard the speculation, that since the enamel organ and the addition of cement lead to an increase in the diameter of the deeper part of the tooth, the tooth accommodates itself to the slightly tapering alveolus by moving forward, a process possibly assisted by the spiral curvature (Fig. 14). Thus the growth of the tooth, in the special case of persistent growth, may itself be responsible for the movement that is constantly going on, not by elongation of the root but by gradual increase in the diameter of its buried portion.

If this be the true explanation, then this puzzling special phenomenon comes into line with the general observations I have previously made. That the force is considerable is well known, witness the re-entrance into the skull of the tips of the maxillary teeth if for any reason they be unopposed, but then the force of eruption is also considerable; although in the case of eruption an external force may be sufficient to deflect the tooth because of the accommodating nature of bone growth, in the forward movement of a persistently growing tooth the force of the increase in its diameter in a socket, which, if the tooth stays where it is, will soon be too narrow for it, cannot be denied.

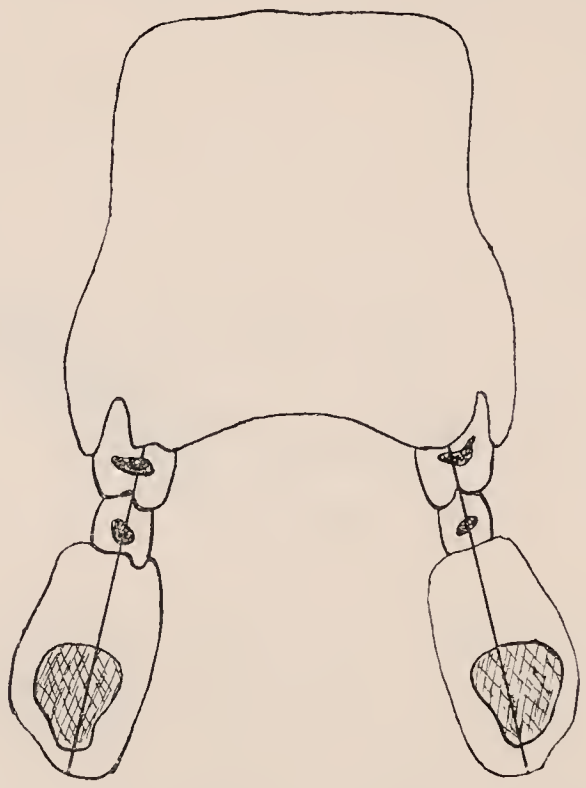

FIG. 15.—Outline of frontal section of the jaws of a pig, 17 weeks old, through the fourth milk molars, to indicate the direction of growth of the maxillary and mandibular alveolar borders in that region. *Cf.* Fig. 16. x $\frac{2}{3}$.

I hope in due course to be in possession of a complete series of madder specimens to illustrate these points, at present, as I have said, in the speculative stage, by the growth, eruption and persistent growth of the canine in the pig. Meanwhile I can only say that a consistent theory of the movements of the teeth must not only account for the ordinary movements of ordinary teeth but must also offer an explanation of all special cases. Another example, in which there is evidence amounting to proof, will be cited after the discussion of movements of the teeth forwards in the alveolar border.

Movements of the Teeth in the Labial Direction in the Growing Alveolar Border.

The second line in which movements of the teeth may take place in the alveolar border is at right angles to its edge, either in a lingual or a buccal direction.

Now there are many recorded facts of increase in interalveolar

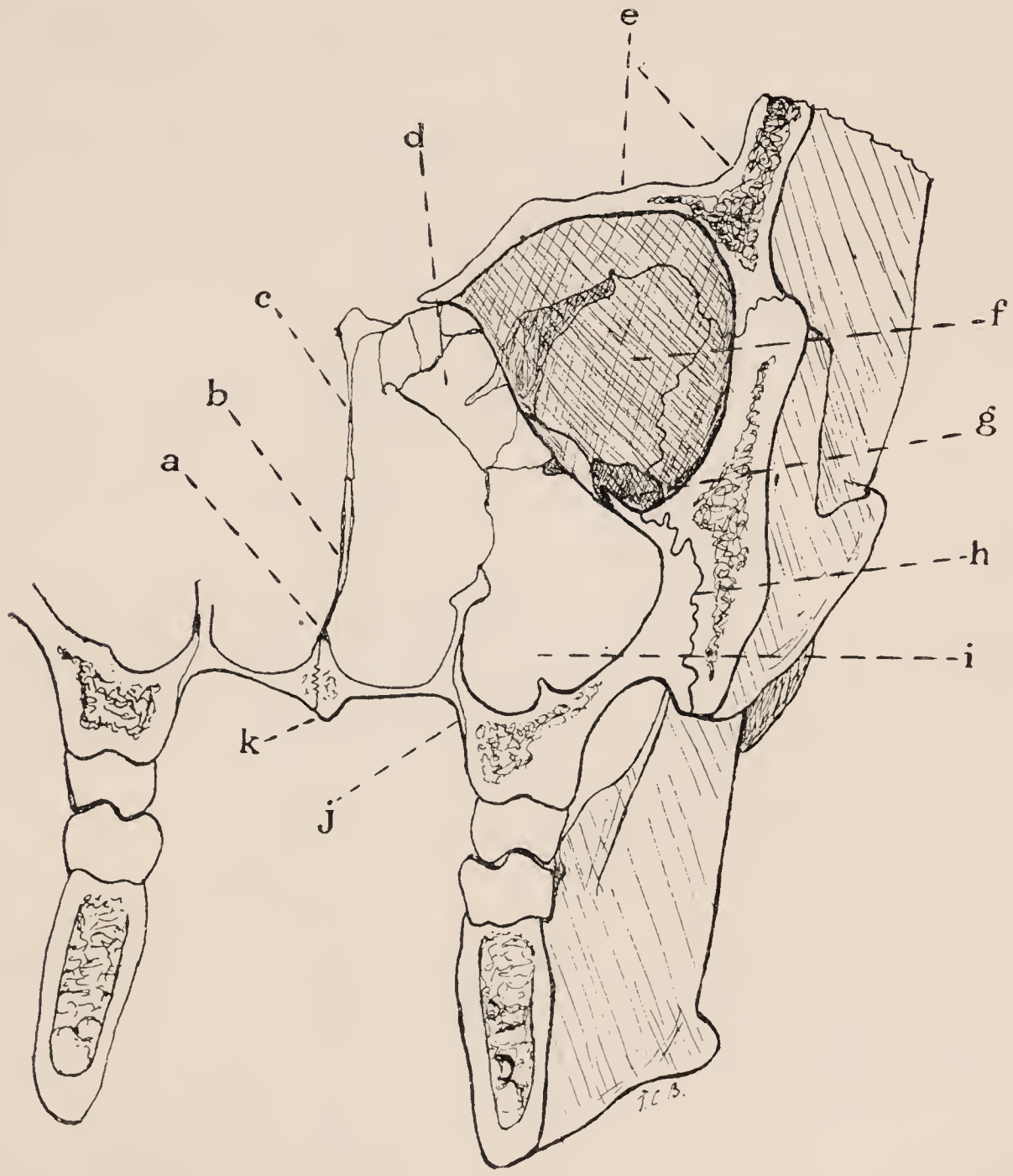

Fig. 16.—Frontal section of human skull, passing between the first and second permanent molars, to indicate the direction of growth of the maxillary and mandibular alveolar borders in that region. x $\frac{3}{4}$. (*a*) Nasal crest; (*b*) vomer; (*c*) vertical plate of ethmoid; (*d*) lateral mass of ethmoid; (*e*) frontal bone; (*f*) great wing of sphenoid; (*g*) infraorbital canal; (*h*) malo-maxillary suture; (*i*) antrum of Highmore; (*j*) palato-maxillary suture; (*k*) median palatal ridge. (Block kindly lent by the Dental Board of the U.K.)

associated with varying rates of deposit of bone on the outer side of the arches; it is not yet possible to assign exact proportions in the widening of the arches to the oblique direction of the alveolar border itself and to the labial movements of the teeth in it.

It may, however, be said that in the mandible, as is anticipated from the varying direction of the alveolar border, buccal movement of the teeth is most obvious in the posterior part of the arch. In the region from the third incisor to the second milk molar it is at a minimum; here the obliquity of the border becomes very great, and it is to be observed that new bone formation on the outer surface is also at a minimum. In the region of the first and second incisors, on the other hand, great forward obliquity of the border is combined with strong additions to the outer surface of the jaw and a considerable labial movement of the teeth.

It is also a matter of considerable interest to note that the corresponding teeth in the two jaws may be increasing their interdental distances under quite different conditions. The last milk molars and the first permanent molars owe their increasing separation in the maxilla mainly to the oblique buccal direction of the alveolar border, whereas in the mandible it is wholly due to buccal movement in a growing border which is lingually directed. This is equally true of the human jaws, and it raises the question of the possible control of the mandibular movement by the maxillary separation. But discussion of questions of this nature, which might conceivably be made the subject of experiment, is not within the scope of this paper, in which I am concerned only to demonstrate the facts of bone growth which can be observed in the alveolar border.

As a special case of bucco-lingual movements I may perhaps cite the course which the permanent molars follow as they erupt and come into occlusion. For as these teeth erupt and come into antero-posterior line with the teeth in front, they must, on account of their developing position in the root of the coronoid and in the alveolar bulb of the maxilla, undergo a rotation (Fig. 17). In the mandible the long axis of the molars as they begin to erupt is directed forwards and inwards in accordance with the direction of the root of the coronoid process in which they develop, and as they erupt they rotate, clockwise on the right, anti-clockwise on the left, both moving buccally at their proximal ends and lingually at their distal. The maxillary molars on the other hand are first directed with their long axes forwards and outwards in accordance with the ine of the posterior extension of the alveolar process which I have

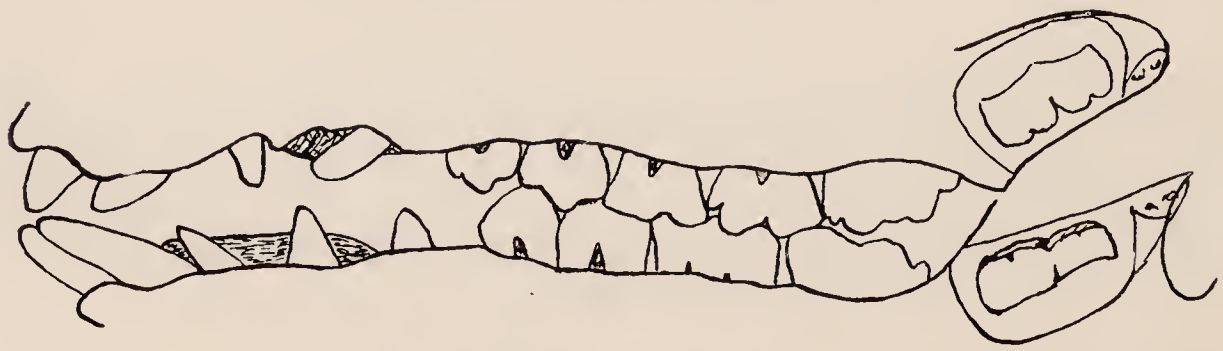

FIG. 18.—Outline of the left maxillary and mandibular alveolar borders of a pig 20 weeks old with the contained teeth to show the vertical relation between the posterior continuations of the borders into the root of the coronoid in the mandible and the "alveolar bulb" in the maxilla. The forward and downward direction of the maxillary border in the region of the cheek-teeth may also be noted. x $\frac{2}{3}$.

termed the bulb. They, therefore, rotate as they erupt in the opposite direction to the corresponding mandibular teeth. But this is not the only peculiarity of the movements of the molars during eruption, since their crowns are also set obliquely to the horizontal plane. The extension of the mandibular alveolar border is clearly distinct in the root of the coronoid, and projects through the inferior dental foramen in the pig, and the corresponding maxillary alveolar bulb (which is to be compared with the alveolar extension on to the posterior wall of the antrum in the human maxilla) also slopes upwards. The crowns of these teeth are, therefore, from the beginning of their development in astonishingly close approximation to each other when the jaws are closed (Fig. 18). Their directions are moreover reciprocal as the maxillary look downwards and backwards, and the mandibular upwards and forwards. As these teeth erupt, therefore, they not only rotate in the manner described, but they both appear to descend into the newly formed parts of the alveolar borders which are to receive them, the maxillary from above in the direction of eruption, and the mandibular also from above apparently in the direction opposite to that of eruption. This is an appearance only, since what actually happens is that the parts of the coronoid and of the bulb in which they lie become transformed into alveolar border, but it is worthy of note that the maxillary molars come down by the rapid growth of their crypts towards an alveolar border which is growing away from them, whereas the mandibular attain the same position by the rising of the alveolar border to the corresponding level. At the same time both the teeth undergo a rotation in the vertical plane so that the posterior part of the crown of each travels downwards as they assume the horizontal position. These movements are of course well known in the eruption of the human molars, and a failure to complete the rotation in the vertical plane is commonly responsible for impaction of the last molar in the mandible. The point is that these movements are taking place and are normally completed before the teeth have come in contact with one another, and it is hardly possible to conceive any force capable of producing them other than the corresponding bone additions and absorptions which can be exactly traced in the jaws of madder-fed pigs.

Movements of the Teeth in the Proximal Direction in the Growing Alveolar Border.

The third line in which teeth may move in the alveolar border is the proximo-distal, and we may again note the necessity of postulating a movement forward of the molar teeth in the human jaws if the milk and permanent arches are to be superimposed by means of the incisors, a necessity that becomes the more imperative in view of the labial movements of the incisors as the arch grows. But we do not yet know the exact mode in which the anterior part of the human arches is reformed during growth, and the relation there between oblique direction and labial movements of the teeth. In the pig's jaws on the other hand, if the attempt be made to superimpose the milk and permanent arches by means of the incisors (taking no account of the obviously great forward growth in that region), then it is clear that there must be a backward movement of the cheek teeth—a result which is so obviously wrong that we fall back upon the growth point of view for a solution.

Now during the growth of the pig's jaws there is a constantly

increasing interval between the central incisors and the second milk molar or premolar teeth, with constantly increasing spacing between the canine and the teeth on either side of it. This separation is a feature of the growth of the jaws in many animals, extending in some to the other premolars, and it is still sometimes attributed to "interstitial growth." This hypothesis is no doubt the only possible explanation on the erroneous assumption that the plane of the alveolar border is stationary, and that the growth of the jaws takes place at the non-alveolar border. It is, however, clear in madder-fed animals that the increasing separation of these teeth and the widening of the part of the arch in which they are set is associated with the growth of the border in an oblique direction and the labial movements of the teeth. The same factors must account, as I have already suggested, for the widening of the arch and the separation of the milk teeth in the human jaws.

It might be settled by measurement, if a sufficiently large series of jaws were available, whether the lengthening of the anterior part of the arch by these means does in fact account for the amount of spacing that is observed between the teeth. If not, then the cheek teeth must have moved backwards, but if on the other hand the oblique growth of the alveolar border and the labial movements of the teeth combined are more than sufficient to account for the spacing of the teeth, then it would be equally certain that the cheek teeth had in the meantime moved forward in the border, and by so doing had diminished in proportion the amount of space gained by the other method. There is, however, absolutely no means of determining by measurement alone what is happening in this region, but the evidence from madder specimens points undoubtedly to the latter of these two suppositions as the correct explanation of what occurs.

There are in fact three sources of evidence in madder specimens for a proximal movement of the teeth in the alveolar border; of these two are direct and the third indirect. (1) The first is the distribution of new bone in the walls of the alveoli. I may recall here the passage previously quoted concerning the difficulty introduced by the vertical movement of teeth with spreading roots, and the consequent effect on the distribution of new bone and absorption in the walls of the alveoli. Nevertheless, when this is taken into account and the necessity of interpreting every detail of appearance in madder specimens fixed firmly in the mind, the picture that begins to present itself in broad outline is a clear and a constant one; as detail after detail is rigidly examined and fits itself into the general scheme, forward movement of the teeth in the alveolar border becomes as certain as upward and outward. The indication of proximal movement in the case of a tooth set vertically in the border is the presence of new bone on the distal wall of the alveolus, while on the proximal wall either it is present in much smaller amount or a red appearance indicates actual absorption. In varying degree, and combined in various ways with the other types of distribution which indicate movement upwards and labially, this arrangement is to be found in the alveoli of all the teeth in the pig's jaws.

The clearest evidence for a proximal movement of the teeth, from the point of view of the distribution of new bone in the alveoli, is to be found in the case of the second and third milk molars, which are set nearly vertically in the jaws. An examination of the

distal surfaces of the alveoli from before shows that they are covered with new white bone; turn the jaw round and the red appearance of the proximal surfaces is equally striking. So with the fourth milk molars and the permanent molars in succession, depending upon the age of the animal, though here the combination of upward movement with oblique roots and the rotation which takes place during the eruption of the molars has its effect, so that the distribution of the new bone varies in the lingual and buccal alveoli. I am well aware of the effect of a slight obliquity of the teeth, and have taken this into consideration in making these observations; but the fact that these teeth have obliquely separated roots renders in some specimens the evidence for forward movement only the more conclusive. It was the combination of the different movements, as I have already pointed out, as well as the fact that owing to upward movement the lower portions of the alveolar walls alone are available for observation, that made it a little difficult at first to arrive at the true explanation. Detailed study has, however, convinced me that forward movement is a reality.

I think it probable, however, that conviction in others may also depend upon personal examination of the details in the individual alveoli; the difficulties of illustrating these details *in extenso* are considerable, and pending the elaboration of some method of doing so that may enable me to give a complete description of the whole course of the movements of each tooth individually, and at the same time to provide a comprehensive view of all the movements of all the teeth in the jaws of the pig, a modification of the previous diagram to illustrate the principle of the distribution of new bone as teeth move forwards may help to sustain and clarify the argument.

In the first diagram (Fig. 9) I have shown the distribution of new bone and of absorption areas in the alveoli of a tooth with spreading roots, applicable alike to mandibular roots in the proximo-distal, and maxillary in the bucco-lingual directions. That diagram may be easily modified, not merely hypothetically but in actual accordance with the observed facts, to show the distribution of deposit

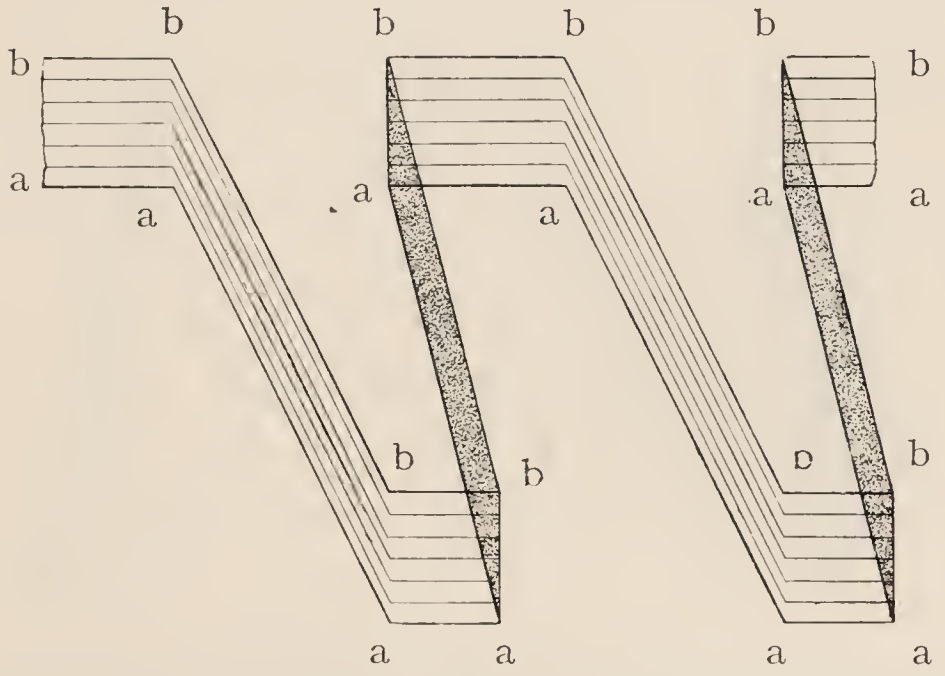

FIG. 19.—Diagram of the sites of bone deposit and absorption associated with the vertical rise of a tooth with double obliquely parallel roots: a-a-a and b-b-b, original and new surfaces of alveolar border and alveoli. The sites of deposit of new bone and the successive position of the new surfaces are indicated by the series of parallel lines, and the sites of absorption by stippling. Bone deposit and absorption overlap at alveolar edge and apex as in Fig. 9. *Cf.* also Figs. 20 and 21.

and absorption during vertical rise when the roots, as they often are in mandibular teeth, are set obliquely in the same direction instead of being separated from each other (Fig. 19). Equally well these two diagrams may be modified to illustrate the effect of a combination of forward with upward movement of the two types of teeth, obliquely set with parallel roots and vertically set with diverging roots. In the particular modifications shown it is assumed that the forward movement of the teeth has been equal to the horizontal distances in the other corresponding diagrams between the original and final positions of the alveolar surfaces of the inter-alveolar septum (Figs. 20 and 21).

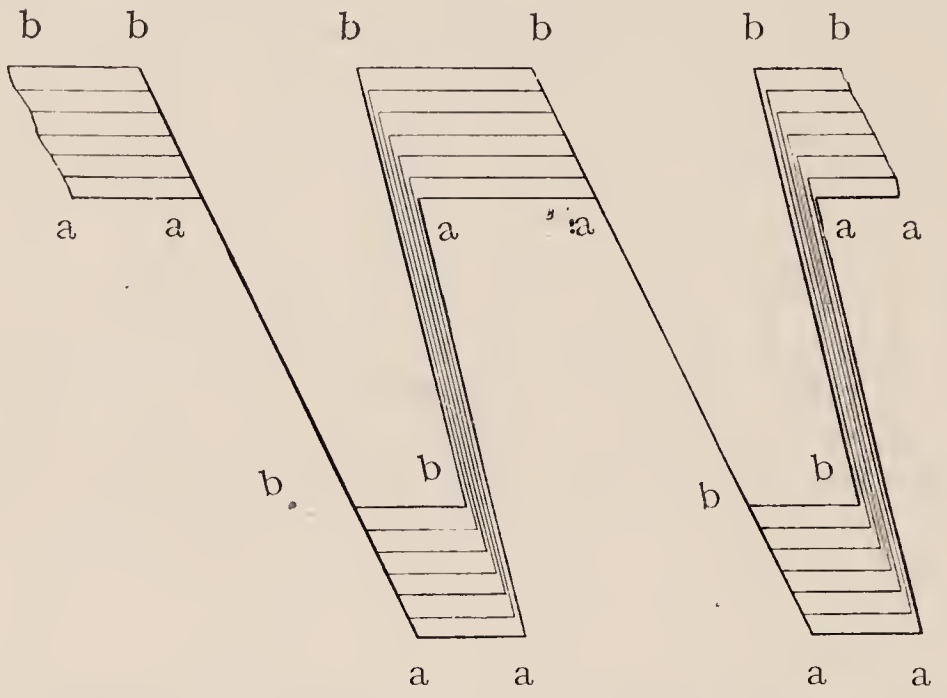

FIG. 20.—Diagram of the sites of bone deposit and absorption associated with vertical *and forward* movement of a tooth with double obliquely parallel roots: a-a-a and b-b-b, original and new surfaces of alveolar border and alveoli. The difference between this figure and Fig. 19 is explained in the text. *Cf.* also Figs. 9 and 21. This diagram represents the probable main changes associated with the rise and forward movement of the human mandibular molars.

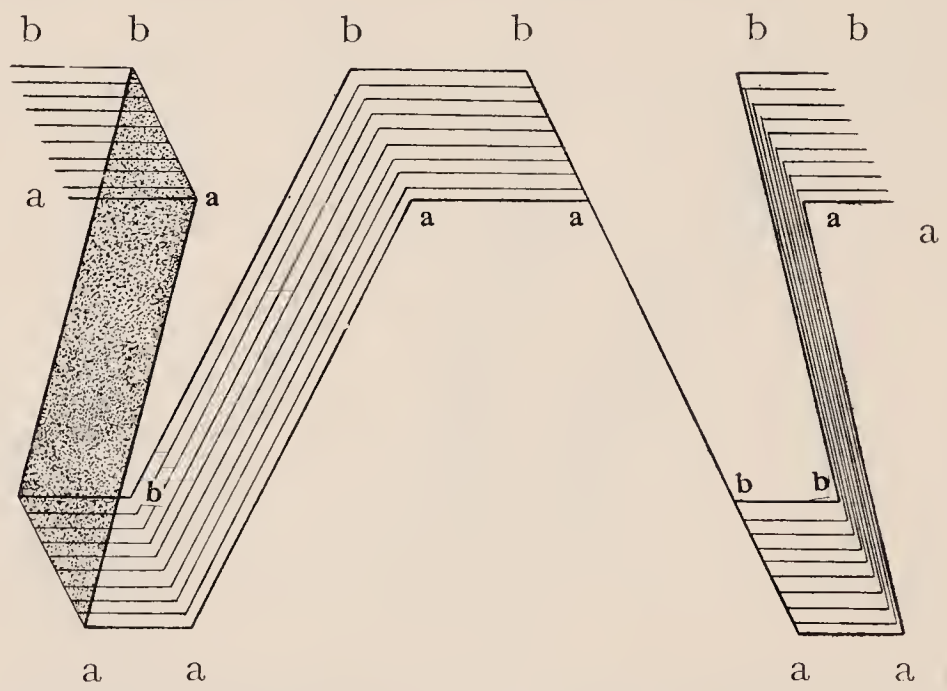

FIG. 21.—Diagram of the sites of bone deposit and absorption associated with vertical *and forward* movement of a tooth with double obliquely separated roots: a-a-a and b-b-b, original and new surfaces of alveolar border and alveoli. Compare particularly with Fig. 9, to which this diagram is complementary, and also with Figs. 19 and 20. This diagram applies equally well to the changes in the lingual and buccal alveoli of a maxillary tooth moving upwards *and outwards*.

These diagrams speak for themselves, but it may be pointed out that the new bone formation, apart from the upper portions of the alveoli which are entirely new, is now found on the distal surfaces of both alveoli and on the apices; absorption is limited to the proximal surface of the proximal alveolus of the tooth with divergent roots, including a small portion of the new bone at the alveolar border, while the proximal surfaces of the distal alveolus in this tooth and of both alveoli in the other have suffered no change at all; a more extensive movement in the proximal direction, or the same movement with less in the vertical, would be accompanied by absorption on these surfaces also. Description of the process in such terms may sound a little complicated, but an ocular demonstration of the changes that take place may be readily obtained by the simple expedient of making an opaque copy of the original alveoli on transparent paper, by superimposing this upon the diagram in its original position and moving it in the required direction.

It need only be added that if the distribution of new bone and absorption that must accompany vertical movement of teeth with oblique or divergent roots be kept carefully in mind, then variations in the directions indicated in these diagrams prove only the more conclusively that forward movement has taken place. If we compare Fig. 19 with Fig. 20, this point is very strikingly brought home. At first sight the distribution of new bone in Fig. 19 might easily lead us to suppose that the tooth had actually moved backwards, if we did not fully realise that a vertical movement of a tooth must be accompanied by deposit of new bone on the lower surface of the alveolus whether proximal or distal. An intermediate stage between these two diagrams might easily be prepared to demonstrate that in certain circumstances a proximal movement of a tooth may even be accompanied by new bone on the proximal surface of its alveolus and absorption on the distal. It is clear also that if a tooth is obliquely set in the alveolar border with its crown in advance of its roots, as is indeed the case with many teeth, then a simple elevation of the tooth in the direction of its long axis will necessarily lead to its simultaneous advance. The important point is that all these variations and the corresponding types of distribution of new bone and absorption are not merely hypothetical, but are in fact to be found in the movements and in the alveoli of the teeth of the pig.

(2) The second source of evidence for forward movement of the teeth is to be found in madder specimens in the actual relation of the new white inner edge of the alveolar border to the original red inner edge which is clearly visible below it. This relation is much more obvious in the mandible than in the maxilla for reasons already stated in the discussion of labial movements; it was illustrated in Fig. 9 in my first Dental Board Lecture in 1924, though not very clearly, as I did not then realise its true significance.

If the inner aspect of the mandibular alveolar border be examined closely, it will be observed that from the region of the first deciduous molar backwards the relation of these white and red edges suggests that the individual alveoli have not only altered their position in the upward direction but that they have moved distinctly forward (Plate II). All the hollows and elevations of the alveoli and septa are in advance of the exactly corresponding points visible in the wavy outline of the former edge. This is not only so with the

alveolar outline of the very obliquely set first deciduous molar, but is also to be observed in the minutest detail, including the positions of the "gubernacular" orifices of the premolar crypts, with all the other alveoli, irrespective of their set in the border. Not only is the inference clear, but we possess in this relation a means of measuring directly the advance of the teeth, which is very welcome in view of the very great difficulty of relating the comparatively small increments on the walls of the alveoli to the various angles of their slope.

Without detailing the individual measurements, I may say that a calculation from all the mandibles available indicates that the cheek teeth are advancing in the alveolar border of the mandible of the pig from the tenth to the thirty-second week at a rate varying from a mere trace in the earlier stages to ·25 mm. a week in the later. The average rate of advance during this period is ·175 mm. per week, and although this may appear to be a small amount, yet it means an advance of the teeth of nearly 4 mm. in the period covered, and even on the assumption that this average rate is maintained—and all the appearances are in favour of a steady increase in the rate as the molars erupt—it means that during the period of the eruption of the molars which, including the complete separation of the last molar from the root of the coronoid process, extends over some eighteen months, the cheek teeth in the pig have advanced *in the alveolar bone* to the extent of nearly 14 mm. As the crown of the first permanent molar measures from 17 to 18 mm. in the proximo-distal direction, if we allow for only a very slight increase in the rate of advance, we are justified in concluding that the forward movement of the molars during the period of their eruption as a whole may amount to a displacement equal to the diameter of the first of the series. Such a movement would considerably minimise the importance of the "cutting back by absorption" of the anterior border of the coronoid process to set free the molars as they erupt, considered by most since the time of John Hunter to be a fundamental point in the growth of the mandible. I believe, with Mr. Wilson Charles, that absorption of the coronoid has been much exaggerated, not only because I have satisfied myself that the molars move forward, but also for other reasons (different also from his) which become of importance in connection with the third and indirect source of evidence for that forward movement.

(3) As I have just indicated, it has been generally believed, since John Hunter's original description of the growth of the mandible, that extension backwards of the ramus and simultaneous absorption of the anterior border of the coronoid, though to a smaller extent, are sufficient explanation of the appearance of the molars from beneath its root and of the slow increase in breadth of the ramus itself. But this conception, like the vertical growth of the body, falls now to be reviewed in the light of our new knowledge of the continuous and all-important upward growth of the alveolar border, as well as in relation to the forward movement of the teeth.

Space for the successive appearance of the molars from the root of the coronoid is, I believe, obtained in three ways: (*a*) by the upward growth of the alveolar border carrying the teeth with it in relation to the sloping anterior border of the coronoid, the amount obtained in this way varying in different animals and at

different ages according to the set of the coronoid; (*b*) by the forward movement of the teeth themselves; (*c*) by absorption of the anterior border of the coronoid.

I have placed these three factors in the emergence of the molars in what I believe to be the order of their importance. Nevertheless, the question of the amount of the absorption of the coronoid and its relation to the form of that process is of fundamental importance for the study of the growth of the mandible as a whole. I hope later to show that absorption of the coronoid falls into line with generalisations founded on other evidence, in that it is limited to a moulding of its contour as the coronoid and the alveolar border both grow upwards, incidentally assisting to open out the mouths of the crypts of the molars in succession as they also rise and move forward. With these remarks I may now proceed to point out the basis of the third possible source of evidence of the forward movement of the teeth.

If it becomes possible in the development of this work to estimate the amount of space, if any, provided for the molars in succession by absorption of the anterior border of the coronoid, and by careful measurement of the angles between the vertical axis of the alveolar border in the molar region and tangents to the anterior border of the coronoid, to estimate the amount obtained by direct upward alveolar growth, then any additional space required to account for the emergence of the molars would necessarily be due to their actual forward movement. But the old difficulties of finding fixed points from which to measure and compare increasing width of ramus with observed amount of bone addition to its posterior border, and the individual variations which necessitate a very large series for any such procedure, have hitherto prevented me from coming to any satisfactory conclusion on these lines. It has, however, been borne in upon me that absorption of the anterior border of the coronoid is undoubtedly very small, and confirmatory evidence of the forward movement of the molars may perhaps be forthcoming through other methods of estimating it.

To sum up the position with regard to forward movements of the teeth in the alveolar border, there is evidence from two sources that the cheek teeth of the pig do in fact move in that direction; an estimate can be made of its amount from direct evidence, and the immediate conclusions which follow are these: First, we can be directly certain that in investigations of changes in the alveolar arches we are no longer entitled to assume that the first permanent molar is a fixed point any more than any other point in the "system of relativity" that constitutes the jaws. It moves not only upwards and outwards in the alveolar border but also, and at the same time, in the third direction as well. Secondly, a continuation of forward movement of the molars with lack of expansion of the anterior part of the arch for whatever reason—lessening obliquity of the border there, or relatively deficient growth—will lead directly to a crowding of the teeth; we have here the evidence for a movement which I think I am right in saying has long been taken for granted by many dentists as one of the causes of such crowding.

All the observations upon which the conclusions regarding the forward movement of the teeth have been directly based have been made in the mandible; there are difficulties in the way of making entirely satisfactory observations of the same nature in the maxillæ.

Not only is the red edge of the original alveolar border covered in part by bone additions associated with the descent of the palate, but also, as we have seen, the amount of alveolar growth is not so great. Direct observation of the interior of the alveoli, however, undoubtedly shows that the distribution of new bone and absorption is on the same general lines. The indirect method, corresponding to that suggested for the mandible, by using the backward travel of the malar process, suffers also from corresponding difficulties, and moreover is less satisfactory on its own account, because of the changing form of the malar process and the difficulty in the pig of determining its exact relation to the alveolar border. The impression I have received from a careful comparison with the mandibular alveoli is that movement of the teeth forward does in fact take place in the maxilla, but that it is less extensive than in the mandible.

A discussion of the possible reasons for this, in the absence of precise knowledge of the relative extent of these movements in the two jaws, would lead us too far at the present time, but it may be suggested that there are other observations which fit in with the probability that movement forward in the maxilla is less than in the mandible. One of these is that forward growth of the jaws in the region of the incisors is greater in the mandible than in the premaxillæ, a possible explanation of which may perhaps be found in the fact that the maxillary and mandibular borders as a whole are related to each other in a sagittal plane in much the same way as their molar regions are related in a coronal (Fig. 18). Both the borders in the region of the cheek-teeth slope slightly upwards from behind forwards, and it would appear that downward growth of the maxillary border would in itself thus carry the teeth forward to some extent as the molars are carried outward, but that on the other hand there would be a correspondingly greater necessity for the mandibular teeth to move forwards in a border rising in an opposite direction in order to maintain their occlusion. The forward growth of both jaws in the incisor region is associated with the progressive spacing of the anterior teeth, and the extra forward growth of the mandible might thus be accounted for by the sagittal relation of the two borders and the necessity of providing for the greater forward movement of the mandibular teeth. These, however, are but tentative suggestions, the proof of which will depend upon the possibility of determining precisely the relative amounts of growth and of the movement of the teeth in relation to the reciprocal curvatures of the alveolar borders.

It remains to observe, apart from the importance of the conclusions presented regarding the forward movement of the mandibular teeth for the etiology of crowding of the arch, that it is highly probable that the necessary adjustments of the normal occlusion which take place during the transition from the milk to the permanent dentition in the human jaws are brought about by a mechanism depending upon the relatively greater forward movement of the mandibular teeth in the alveolar border. In this way the vertical straight line of the distal surfaces of the second milk molars, which marks the termination of the eruption of the milk dentition, may give place to the overlapping relation of the permanent molars coming in behind which determines the permanent occlusion which we call "normal."

The Continued Movement in the Alveolar Bone of Molars in Indefinite Succession.

In discussing the question of the movement of teeth growing from persistent pulps I gave it as my opinion that "a consistent theory of the movements of the teeth must not only account for the ordinary movements of ordinary teeth, but must also offer an explanation of all special cases." Before leaving this account of the forward movement of the teeth in the alveolar border, I must therefore make reference to the parallel case of the indefinite succession of the molars which is to be observed in certain animals, notably in the manatee. I have indeed previously suggested that the explanation of the apparently endless series of molar teeth, which in these animals appears from the remarkably independent end of the alveolar process projecting backwards through the dental foramen in the mandible and from the persistent alveolar bulb in the maxilla, is probably that the teeth do in fact what they appear to do—travel forwards in the alveolar bone, the worn-out teeth being shed from the anterior end of the series and their place taken by those coming forward from behind. This was no novel suggestion, as Oldfield Thomas and Lydekker had been forced to this conclusion in 1897 by their examination of a series of the jaws of manatees of different ages. But they were concerned principally to demonstrate that, however old the jaw of the manatee may be, there are always to be found new molars developing in the alveolar ends, and they did not discuss the mechanism of the forward movement or attempt to relate it to the conditions in the jaws of other animals.

I have now no doubt at all, in view of the results I have obtained in the pig, that if the madder method could be applied to the manatee, all the interalveolar septa would display unequivocal new bone on their proximal surfaces and absorption areas on the distal. Observation can indeed be made on these surfaces without madder,

Fig. 22.—The walls of the distal alveolus of the sixth molar tooth in series from the right side of the mandible of a manatee (*Manatus americanus*.) (A) Distal surface showing the transverse ridges of new bone ending on both lingual and buccal sides in vertical advancing edges; (B) proximal surface showing the characteristic pitted appearance which denotes bone absorption. All the alveoli, maxillary and mandibular exhibit the same appearances.*

* Very slightly enlarged.

though lacking its dramatic effect, and a simple inspection of the interalveolar septa of the manatee proves beyond a shadow of a doubt that bone deposition and absorption have been proceeding in the situations specified (Fig. 22). Every molar alveolus in the manatee is in this respect the same ; the proximal wall displays the irregular pitted surface which is characteristic of absorption, while the distal wall is covered by new bone arranged in a regular series of horizontal ridges which extend just to the labial and buccal walls where they end in a continuous sharply raised edge which has obviously been slowly creeping forwards. Thus forward movement of the teeth themselves becomes the sole cause of their displacement relative to the coronoid and the malar process after the full growth of the jaws has been attained, and another special case is brought into line with a general principle.

This simple observation opens to us a wide and fascinating field of comparative inquiry, by which in the end all manner of variations in tooth position and tooth movement may be brought together and explained by the general principles of bone growth ; but enough has been said for the present.

The Changes in the Crypts of Successional Teeth in Relation to the Movements of their Predecessors.

Having now dealt in turn with the general arguments for the movements of the teeth in three different directions in the alveolar border, it remains only to make some brief observations on the changes undergone by the crypts of the successional teeth in relation to the combined movements of their predecessors, so that we may be in a position to take a complete view of the principles which underlie the actual eruption of the teeth in the light of the whole history of their movements in the alveolar bone.

The enlargement of the crypts of successional teeth before "eruption" is definitely related to the direction of the movement of their deciduous predecessors. The constant movement of the milk teeth explains the relative position of their respective successors, the most obvious example being that from this point of view a new light is shed on the necessity for the lingual situation of teeth which are to succeed others which are constantly moving buccally.

As the growth of the jaws proceeds, not only do the crypts of successional teeth enlarge but they also "move" by absorption, and at certain stages by a change from absorption to bone deposit in the deepest part of the crypt or on one of its walls ; the crypts with their contained tooth-sacs thus move in an upward, labial and proximal direction. This "movement," owing to the increasing size of the crypts in the early stages, is at first mainly an alteration of the position of their centres by "differential absorption" greater in that direction. The "movement" of the tooth-sacs, really in the three directions though apparently mainly towards the surface, being accompanied by increase in their size and related to the direction of movement of their predecessors, the absorption incidentally includes the roots of the latter. When the tooth is sufficiently developed, and the roots of the deciduous tooth correspondingly absorbed, the concealed movement of the tooth-sac, which in the later stages is due to a balance of deposit and absorption on opposite sides of the crypt, gives place to a

manifest movement of the tooth by a change of the emphasis from absorption to deposit. The remains of the milk tooth are extruded in an upward and labial direction, the tissues of the tooth-sac are reduced to the alveolo-dental periosteum, and the rapid growth of the alveolar bone not only forms a socket around the tooth but raises it bodily to and beyond the surface.

This is the stage we call "eruption" but in the light of our new conception of the whole history of the continuous movements of all the teeth, it may now take its proper place in that conception as a mere phase of a general process, a phase which requires no special "theory" to explain it. The general process, of which "eruption" is the only part that has always been manifest and has therefore attracted attention, commences with the first formation of the crypt around the developing tooth, continues with the further excavation of that crypt and its enlargement towards a surface which is continually receding from it, and passes through the stage at which the tooth actually emerges from the bone into the continuation of the same process which is found in the continued rise and other movements of the erupted tooth thereafter with the continued growth of the alveolar bone. The slowing down of the process when the tooth is "fully erupted" is probably conditioned by contact with opposing teeth, and its final stage may perhaps be found in the further rise and final slow extrusion from the alveolar bone of teeth which are unopposed.

How Long do the Movements of the Teeth Continue?

The conception thus completed by including "eruption" as a phase of the continuous movements of the teeth, and the facts of continued movement after "eruption," give rise to a final question to which I can make only brief reference; for to this question we are not yet in a position to give a detailed answer. How long do the movements of the teeth continue?

If, as is probable, they may all be included under a generalisation which applies to the growth of the whole skeleton, and may be explained as part of the remodelling process which is a response to and proceeds simultaneously with increase in size of the jaws, then it would follow that such movements of the teeth, maintaining their relative position as all parts of the jaws are maintained relative to each other, must in general gradually cease, as other remodelling processes necessarily do, with the cessation of growth.

Vertical movement is in this respect perhaps in rather a different category from the others, in that it is compound. The vertical movement which merely maintains relative position, and is therefore strictly comparable with labial and proximal, is perhaps to be regarded as superimposed on a more fundamental vertical movement which throughout the history of the tooth is responsible for an alteration in its relation to the surface. When opposed, as in the stages before "eruption" by the necessity for the absorption of bone and perhaps the roots of a predecessor, or after "eruption" by articulation with the teeth of the other jaw, this altering factor in vertical movement is slow working. It is most rapid during the unopposed period of actual "eruption," and again becomes manifest later if opposition be wanting. Thus vertical movements may be possible throughout the life of the tooth, though in later stages they may not be conditioned at all by general growth of the jaws.

It must also be remembered, apart from the difficulty of defining what we mean by "growth," that remodelling processes, with absorption in the principal rôle but accompanied by deposit of bone on a minor scale, may continue throughout life and become obvious and even dominant in old age as the response of the bones to changing conditions, such as alterations of stress and the shrinkage of soft organs. The general form of the skeleton must largely depend on the reaction of the individual bones in some mysterious fashion by bone deposit and bone absorption to the mechanical necessities of their own fundamental form as they grow in size, and to the physiological strains imposed upon them, by their relations to other bones and by the tone and co-ordinated contractions of the muscles. The response to such influences can never be merely local, but must always be in the nature of an alteration of the whole bone by deposit and absorption in appropriate situations, irrespective of the points through which strains are transmitted such as the articular ends or the attachments of individual muscles.

The jaws are no exception to these general principles thus lightly sketched, and it follows that throughout life, with slow changes in the strains and stresses to which they are subject, and with alterations in the articulation of the teeth brought about slowly by the consequent changes in the jaws, or rapidly with the loss of some of the teeth themselves, there may be associated the possibility of further movements as part of the continuous but slow process of remodelling and readjustment. It is difficult, therefore, to set a term to the possible movements of the teeth in any of the three directions, though we shall probably not be far wrong if we say that tooth movement as a constant process and a fundamental feature of the development of the jaws comes to a gradual cessation as they attain their full size.

It is of interest to note in this connection that R. Landsberger in two recent papers has described from the appearance of the alveolar bone in madder-fed dogs what he calls a "continuous growth change" (kontinuierliche wachstumsbewegung) in the alveolar bone. Dr. Landsberger specifically refuses to recognise the results he obtained as evidence of actual growth, for he was apparently not prepared to abandon the old conception of the permanence of the alveolar border once it is built up around the teeth and so long as the teeth remain. He therefore came to the conclusion that changes of extremely rapid alternate destruction and regeneration were constantly going on in the alveolar bone, determined, he even goes the length of speculating, by the alternate pressure and release of the teeth in articulation. It is clear, however, to me, after comparing the coloured plates with which his first paper is illustrated with my own specimens, that he was merely demonstrating in the growing dog what I have demonstrated in the growing pig—that the body of the mandible and the maxilla increase in height at the alveolar border. He used the direct method, and the fact that the alveolar border was stained red he took as unassailable evidence that there must be a growth change in the bone which could not be a growth in the ordinary sense, since the teeth and the alveoli were already completely developed. ("Dies ist der untrügliche Beweis, dass in dem Alveolarfortsatz eine kontinuierliche Wachstumsbewegung im Gange ist, auch dann noch, als die Zähne und die Alveolen bereits fertig ausgebildet waren.") Yet

it is obvious from his illustration of the mandible that the red border is much more sharply defined on the lingual side, and that with a similar strongly coloured edge on the buccal side there is a gradual fading downwards on to the outer surface of the jaw, which to me is evidence of continued slight movement in the buccal direction.

It is, moreover, curious that Dr. Landsberger should have come to the above conclusion in spite of the fact that his observations were made on two dogs, the ages of which were only five and eight months. It is a remarkable proof of the strength of the general belief in the absolute dependence of the alveolar bone upon the teeth, and its complete lack of participation in the general growth of the jaws and isolation from influences proceeding from increase in size, that he should have found himself unable to believe that the alveolar border was still growing in the dog at the age of eight months. It is further surprising to note that on this basis Dr. Landsberger stated in his first paper his definite opinion that this process continued throughout life ("der tatsächliche Beweis . . . dass sich in dem Alveolarfortsatz eine kontinuierliche Wachstumsbewegung zeitlebens abspielt"), and very interesting to find that he later found reason to alter this opinion; after examining the alveolar bone of older dogs by the same method, he devoted his second paper to this very point, and arrived at the revised conclusion that the "growth change" is in fact limited by age ("der Zeit nach begrenzt"), and that the critical period in the dog is about the sixth year.

The explanation is that his original specimens demonstrated not a mere "growth change," which may indeed exist, but the actual growth of the alveolar border. The fact that his older dogs did not give him the same result, coupled with my own as yet very limited observations on the jaws of pigs approaching their full size, justifies me in the belief that for all practical purposes the movements of the teeth which I have described come to an end when the full size of the jaws is attained. Dr. Landsberger, on the supposition that the forty-fifth year in human age corresponds to the sixth year of a dog's life, also concludes that regulation of the teeth will be the more difficult the older a man is and the nearer he approaches that period, but that exceptionally after the forty-fifth year there may still be a "growth change," which may facilitate orthodontic procedures.

The phrase "for all practical purposes," which I have used above, is indeed no mere conventional one, but it is not for me, having treated this question, as it must be treated in the first instance if the truth is to be found, as a purely anatomical problem, it is not for me to say what may be the exact bearing of the results which I have presented in this paper on the practical problems of the orthodontist. Having no experience in these matters, I do not know whether it may be found easier to move a tooth *secundum artem* in the direction in which it is naturally travelling at the time or against that direction, or whether such artificially produced, or controlled, movements may be equally successful while physiological movements are still proceeding and after they have ceased. It would appear that after the full growth of the jaws has been attained orthodontic regulation is not so likely to be successful; but it may be that a knowledge of the continual tendency of the teeth to rise, and, when we are in possession of keys to the further

history of the jaws, a knowledge of possible further movements of the teeth, perhaps in reverse directions in response to altering conditions, may enable the orthodontic surgeon to work in older persons as great changes in the position of the teeth as he even now does in the younger.

Summary of Conclusions and Their Relation to the Changing Form of the Alveolar Arches.

1. Alveolar growth is the main, possibly the sole, factor in the growth in depth of the body of the mandible and maxilla. It continues throughout the period of growth of the jaws as a whole, which closes practically with the complete eruption of the third molars.

2. Associated with the general growth of the alveolar bone there are constant additions to the walls of the alveoli and the interalveolar septa which cause a constant movement of all the teeth upwards in the alveolar border.

3. Bone growth in relation to erupting teeth is essentially of the same nature, raising erupting teeth from their crypts to the level of those already erupted, which are also moving upwards at a slower rate. The proximate cause of the eruption of the teeth is a local intensification of the general upward growth of the alveolar bone.

4. The roots of the teeth elongate at the same time, in the early stages being raised with the rest of the tooth as the crown travels a greater distance, at the end of the period of eruption growing down towards the mandibular canal or the maxillary canal and sinus as the crown continues to rise, but at a slower rate.

5. The growth of cementum is an additional factor in the upward movement of teeth both erupting and erupted. The relative importance of this increases slightly with diminishing intensity of the general alveolar growth, but it is probably offset by the gradual diminution in the thickness of the alveolo-dental periosteum.

6. The constant forward movement of teeth with persistently growing pulps is probably due to enamel and cementum additions increasing slightly the diameter of their embedded portions in stationary alveoli; this takes the place of combined cementum and alveolar socket growth in the earlier stages while general growth is still proceeding.

7. There is a constant movement of all the teeth in the labial direction in the alveolar border of the pig during the growth period.

8. The molar teeth are also rotated by appropriate bone growth in their sockets so as to come into line. Mandibular and maxillary molars rotate in opposite directions, and these rotations are complete before the teeth rise to the occlusal plane and come into articulation.

9. It is shown from two different sources of evidence, with possible support from a third, that the teeth also move proximally in the alveolar border. In the mandible a proportion of the space required in front of the root of the coronoid for the erupting molars is thus acquired, and in the maxillæ a part of the backward travel of the malar process accounted for.

10. This movement is greater in the mandible than in the maxillæ, thus facilitating the change in occlusion which takes place in the transition from the milk to the permanent dentition.

11. It is suggested and conclusive evidence produced that bone

growth is responsible for the forward movement of the teeth in the alveolar border, which results in the coming into place of molars in indefinite succession in the jaws of the manatee after their full size has been attained.

12. A consideration of the continuous movements of erupted teeth in three directions during the growth period, and of the relation between enlarging successional crypts and the movements of their deciduous predecessors, suggests that "eruption" is but the manifest phase of a process of movement which begins long before and continues long after it.

13. The first permanent molar cannot any longer be looked upon as a fixed point in any sense from which to measure or superimpose the alveolar arches. Its position, like that of any other point in the jaws, is relative only.

14. The general conclusion is that the alveolar arches are in a constant state of change. Not only is there constant upward growth, the actual plane of the alveolar border carrying the teeth with it being constantly renewed, but there is also a continuous movement of all the teeth in two other directions—buccal and proximal. The actual position of the teeth in the arch at any given time is the resultant of these three movements, the forward diminishing slightly the increase in width of the dental arch due to the upward and outward movements. Differential rates of movement in these three directions will bring about the changes to be observed in the normal development of the alveolar arches, and a disturbance of these movements, however caused, will readily account for anomalies in the shape of the arches and in the position of the teeth.

Detailed application of these results to the normal changes in the human alveolar arches must await a new series of measurements designed to elucidate this question on the basis of observed facts in the jaws of madder-fed animals. Meanwhile it is abundantly clear that the alveolar arches can no longer be regarded as stationary and unchanging, unaffected by the growth of bone, save only in minor degree and locally, as teeth in different places are shed and replaced. They must be considered, on the contrary, as in a constant state of change and reformation. The alveolar arch of the permanent dentition is *quite* a different thing from the arch of the milk dentition. The bone of which it is composed is *entirely* new, and although it may resemble the milk arch in general form and dimensions plus the added portions behind, yet it is not merely the milk arch changed a little in front and extended, but a new formation which has come into existence by the mechanism of bone growth here described, and in conformity with the general growth of the jaws of which it is an integral part.

The importance of these conclusions, if substantiated and accepted, in providing a conception of constant change in the arches, and constant movement of the teeth in the arches during their development, cannot be exaggerated. It is hoped that they may lead through future investigation to an understanding of the exact changes that are taking place in the human alveolar arches at all stages of their development, to a knowledge of the mechanism of departures from the normal, and finally, through discovery of the factors which influence normal and abnormal changes in the position of the teeth, to a complete rationale for orthodontic practice.

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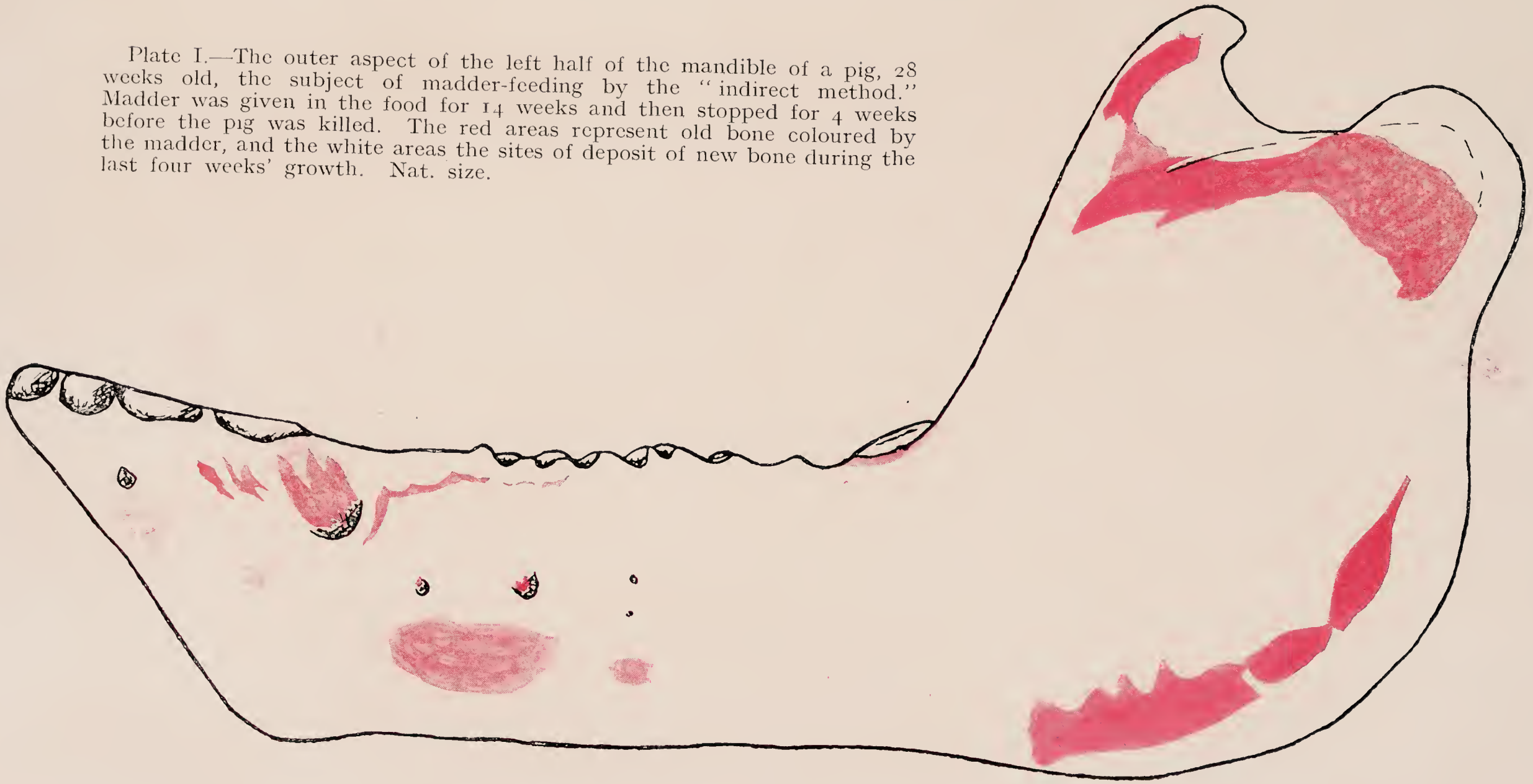
Plate I.—The outer aspect of the left half of the mandible of a pig, 28 weeks old, the subject of madder-feeding by the "indirect method." Madder was given in the food for 14 weeks and then stopped for 4 weeks before the pig was killed. The red areas represent old bone coloured by the madder, and the white areas the sites of deposit of new bone during the last four weeks' growth. Nat. size.



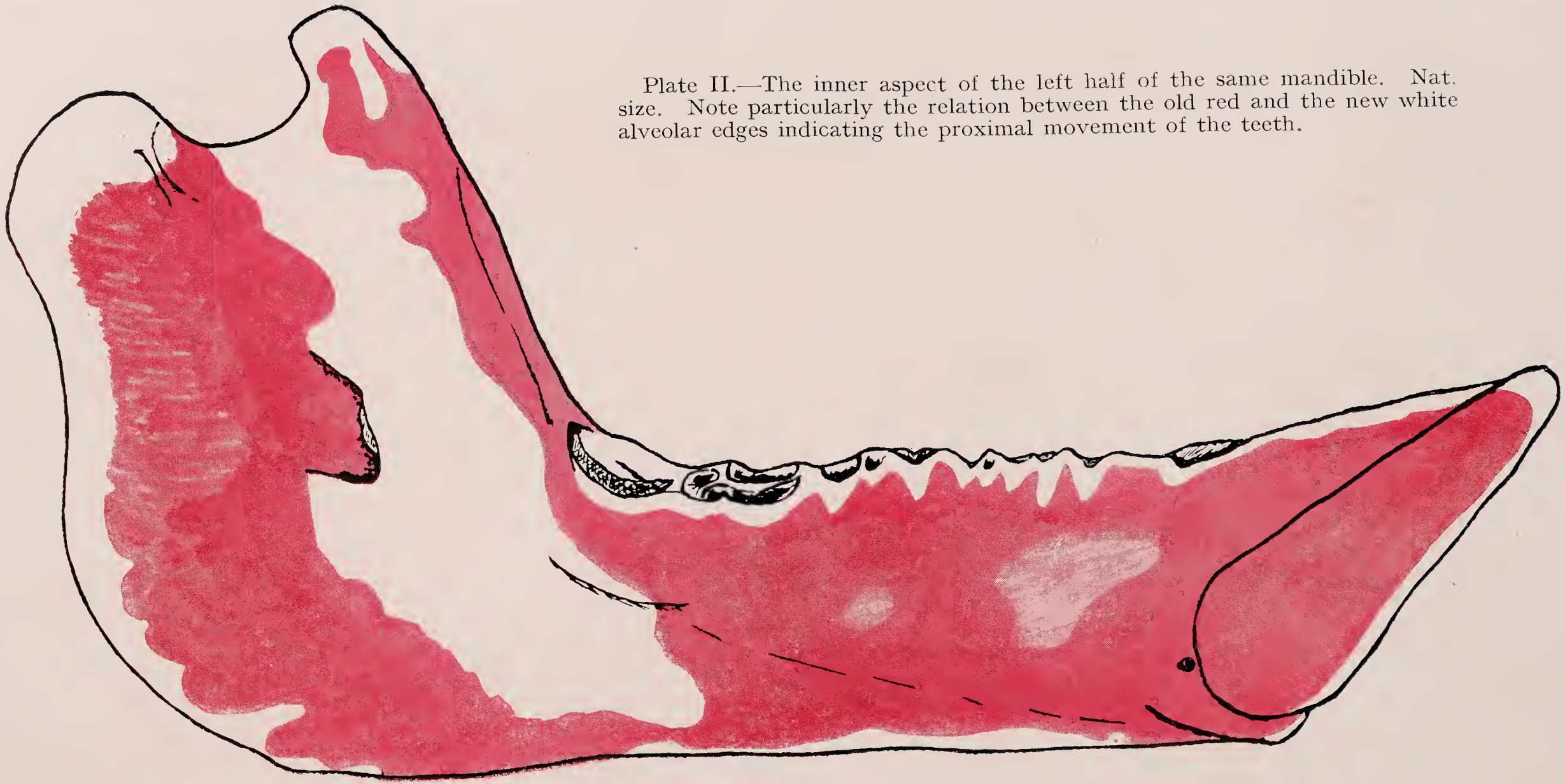


Plate II.—The inner aspect of the left half of the same mandible. Nat. size. Note particularly the relation between the old red and the new white alveolar edges indicating the proximal movement of the teeth.

Plate III.—The lingual side of a " sagittal " section of the right half of the mandible of a pig 26 weeks old, the subject of madder-feeding by the " indirect method." Madder was given in the food for 9 weeks and then stopped for 3 weeks before the pig was killed. The red areas represent old bone coloured by the madder, and the white areas the sites of deposit of new bone during the last three weeks' growth. Nat. size.

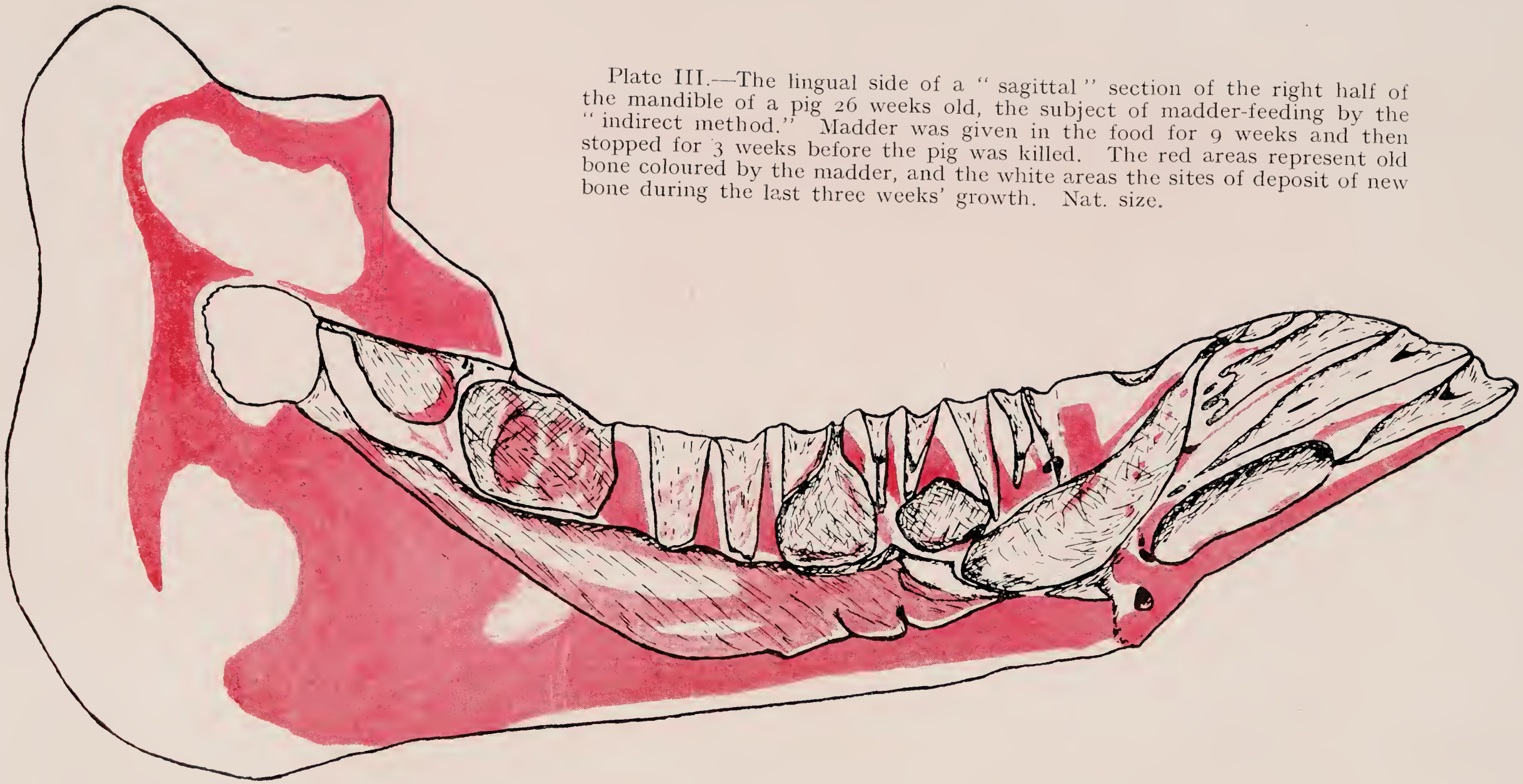
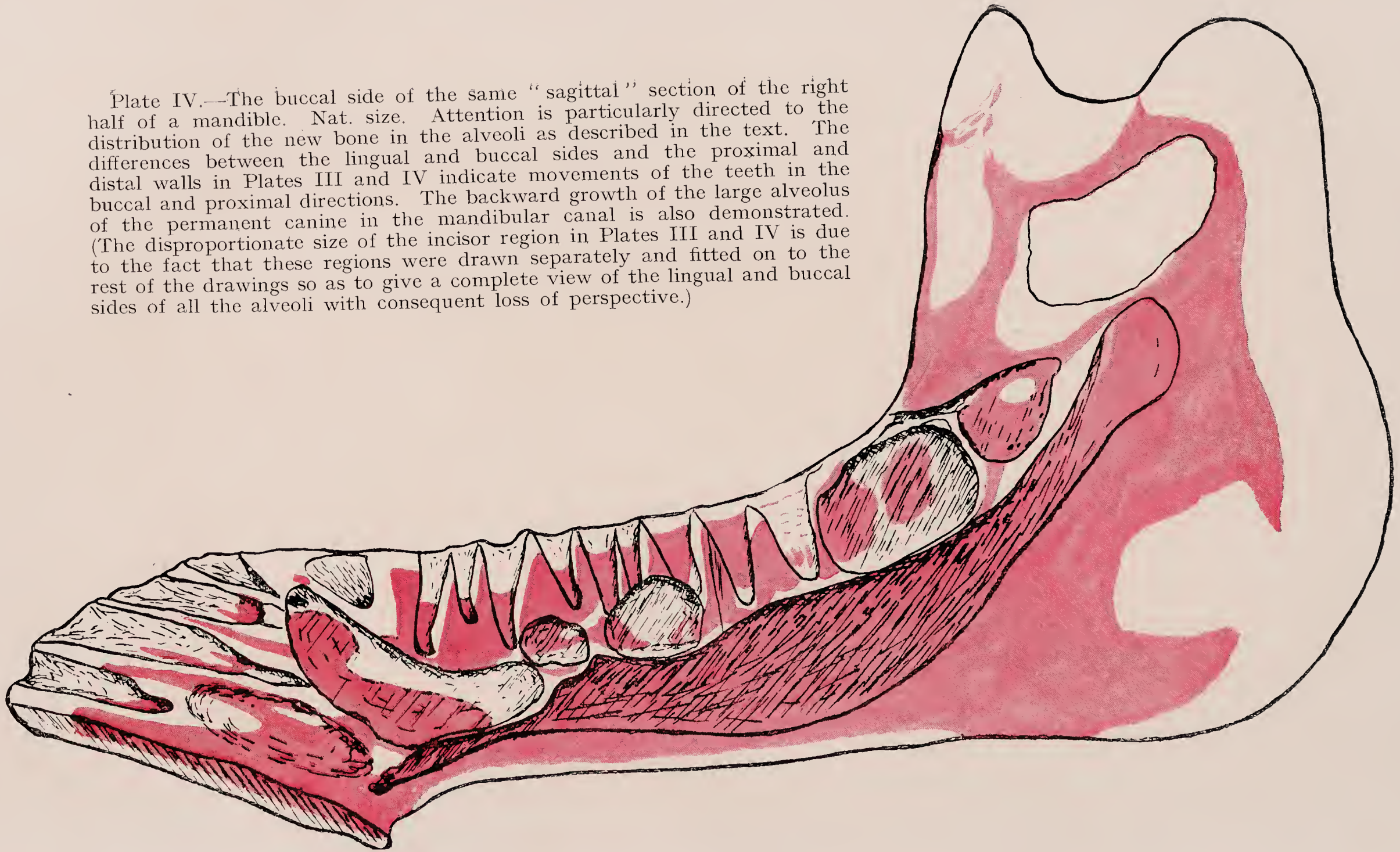


Plate IV.—The buccal side of the same "sagittal" section of the right half of a mandible. Nat. size. Attention is particularly directed to the distribution of the new bone in the alveoli as described in the text. The differences between the lingual and buccal sides and the proximal and distal walls in Plates III and IV indicate movements of the teeth in the buccal and proximal directions. The backward growth of the large alveolus of the permanent canine in the mandibular canal is also demonstrated. (The disproportionate size of the incisor region in Plates III and IV is due to the fact that these regions were drawn separately and fitted on to the rest of the drawings so as to give a complete view of the lingual and buccal sides of all the alveoli with consequent loss of perspective.)



THE GROWTH OF THE ALVEOLAR BONE.

Discussion.

Sir Arthur Keith said that they would all agree that the knowledge of the growth of bone lay at the very basis of orthodontic art. It was really the science upon which that art was founded. It ought to be understood how this growth occurred, and particularly how the jaws grow, but above all it ought to be known exactly how the sockets of the teeth were formed and how all that mass of bone which was called the alveolar bone was regulated in its growth. To his way of thinking, the communication which Professor Brash had made was the most important contribution to this knowledge which had been made in his time. He hoped the Society would permit him for a moment to speak of the origin of the method of studying growing bone, because it might be open to some of them to question both the method itself and the animal which Professor Brash had selected for carrying out his experiments. This was the oldest of all the known methods of vital staining—which at this present moment was throwing such a new light upon the physiology of the body. The discovery of vital staining was made by a surgeon of Guy's Hospital, John Belchier, 190 years ago. John Hunter took it up and was able to show by means of specimens which were still preserved in the Royal College of Surgeons that in the process of building up bones there were two aspects to be considered, one of them the building up itself, and the other, much more important, the absorption or remodelling of bone. Without madder staining the enormous activity that was going on in all bone in health as well as disease would never have been known. Those specimens of John Hunter some eight years ago lost their colour, and the speaker's colleague at the college, Mr. Burne, repeated John Hunter's experiments on three pigs. The speaker was rather interested by some new details which he noticed in these specimens and Mr. Burne then repeated the experiments and extended the time of madder feeding. From these results he saw certain facts which enabled him to say that he agreed with Professor Brash's deductions. Professor Brash had demonstrated these things with a finality which he did not think they attained at the college. For instance, the specimens of bone now lying on the table were more diagrammatic than anything attained at the college. It was in this way that his own attention was drawn to the extraordinary plasticity of the bone of the alveolar area, and his knowledge was augmented by observing what happened in the jaws of acromegalics. It was from the study of such cases that he learned that the whole dentition might not only be shifted forwards but be lifted up by half an inch. Half an inch of new bone could be laid down in the sockets of the teeth and the jaw remodelled without, as it were, a single tooth coming out. He said this by way of preliminary to show that in coming to deal with Professor Brash's results he could talk with some familiarity and could assure the Society that they were not only acceptable and reliable but absolutely sound. They represented, to his way of thinking, a permanent and final contribution to the knowledge of the growth of the jaws and especially the growth and eruption of teeth. The great new fact which Professor Brash had brought before the Society was the extraordinary plasticity and malleability of the bone of the jaws. This, he knew perfectly well, was not new to those practising dentistry because every one of them since starting practice had worked upon that as a basis, that the bone as well as the osteoblasts were really a kind of domesticated "animal" which could be coached and coaxed to do almost anything. He thought that in this respect those in orthodontic practice were ahead of the anatomists, but now the anatomists were getting "square" with them because they had been able to demonstrate, largely owing to Professor Brash's work, the extraordinary plasticity of bone. The teeth were moved in an upward direction, they were also moved forwards and laterally.

Professor Brash had come upon a difficulty which the speaker, and he thought Mr. George Campion also, had felt very much when they were making an investigation of the growth of the jaws and the face—namely, this very modern problem of relativity ; that everything was moving and nothing was fixed. If they could only arrive at a fixed point it would be all right. But there was not any fixed point to be found in the jaws and the alveolar bone. The position of the first permanent molar shifted and was not reliable. He had tried to take certain points which might be fixed, but it was evident from the results of Professor Brash's method that the supposedly fixed points were not reliable, and one had to transfer from the jaws of the animal on which he had experimented to human jaws the results at which he had arrived by means of his madder staining. Some might ask whether the results which Professor Brash had obtained in pigs were transferable to human beings. The answer was that they were transferable, but with certain modifications. A great number of things had to be verified. The general thesis was proved, that the alveolar bone, like a great battalion of soldiers, could be drilled and moved into a position and would move the teeth into any position ; but in the pig's jaw there was a tremendous forward growth. There the forward movement of the teeth and of the whole alveolar region in the pig was infinitely greater than in the human jaw. An important discovery which Professor Brash had made was that there was no new bone being laid down along the lower border of the jaw in the pig. All the bone that was being laid down was alveolar bone, and had emerged gradually into the body of the jaw. That was true of the pig's jaw but not quite true of the human jaw. There were certain things which led the speaker to believe that there was actually a positive deposition of bone both along the lower border and also in the lower chin, and the human chin was very curiously moulded and was very different from the pig's jaw. Professor Brash had very kindly at the end of his paper summarised the whole of his observations. As to the plasticity and the movement of the alveolar bone, the speaker was in agreement, also as to the knowledge of bone growth being the foundation of the knowledge of the eruption of the teeth. Eruption of teeth was essentially a bone movement. He was also extremely interested to see that Professor Brash paid attention to an extraordinary condition which was found in lemmings. In their jaws the incisor growth was permanent, the roots shifting right back to the neighbourhood of the articular condyle. One wondered how such a condition could have arisen, but once it was known how movable and plastic the alveolar bone was, it did not become so difficult to conceive the socket of the incisor teeth slipping back even to the condyle of the jaw.

The speaker had referred already to his observations in acromegaly, and these specimens helped one better to understand what occurred. There was one point which Professor Brash did not include as part of his paper, but which was of the utmost interest and on which the speaker would like to touch. He (the speaker) assumed, in common with other anatomists, that growth took place at the sutural lines of the skull. Professor Brash had come definitely to the conclusion that the sutural lines of the skull and of the face were really not growth lines, that is to say, there was no new bone intercalated in these sutures as such. All that took place there was a superficial growth—laying on of new bone outside, the old bone inside being absorbed. In this way one got growth without actual deposition of new growth in the suture. That was an idea towards which the speaker had been drawn for a few years, but he had turned it down for several reasons. Some day, by such a method as vital staining, one would get to know whether or not new bone was laid down in the sutural lines. He had been studying the growth of the skull a good deal, and from certain appearances which he observed he came to the conclusion that in the growth of the face and also the cranium there was a deposition of sutural bone,

although that other process—superficial deposition on which Professor Brash insisted—was perhaps the more important of the two. There was to be found in the skull a most curious growth of bone. He had seen cases in certain people where the malar sutures were united, with a consequent arrest of growth. He was inclined to doubt very much whether Professor Brash would be able to follow out that thesis of his that the sutures were not really designed for growth. One case came to him from Egypt—the case of a child who was born with all the sutures obliterated, and in that child, although it had lived until its teeth had erupted, the skull had not grown at all. It might be said that the growth had ceased because bone was no longer absorbed from within, for theoretically one could see that it was quite possible to get growth of the cranial cavity without sutures.

He feared that he had not been able to add a single iota to what Professor Brash had laid before the Society. On no point was Professor Brash wrong, and on every point which the speaker had examined he found him right. He had laid the whole subject on a firmer and wider basis than before, and enabled a readier explanation to be given of deformities in the growth of the jaw and mal-eruptions of the teeth, especially in connection with the deposition of bone upon the increase of the alveoli. The increase of the upper alveoli, particularly when one got a deep narrow palate, was without doubt due to a failure of one of the processes of expansion to which Professor Brash had referred.

Mr. G. H. Northcroft said that they must all agree, without undue flattery, that this was a paper of the highest scientific value. The Society might indeed be considered fortunate in being the recipient of the further researches of Professor Brash continuing his painstaking and valuable work initiated by the Dental Board and the Medical Research Council. In the paper they were afforded a clear and reasoned statement concerning the growth of normal alveolar bone and nature's processes observed in the eruption of teeth from which, in time to come, they might hope to deduce the etiology of many of the departures from the normal, especially those involving the growth and development of alveolar bone. Indeed, it would be a fascinating privilege for the Society to follow up and apply this fresh aspect of a complicated subject, presented by such a careful observer and shrewd seeker after truth. It might be interesting to suggest one or two implications arising from the observed facts. The correlated rates of growth made for normality. Professor Brash emphasised a point noted elsewhere, that co-ordination of varying rates of growth at different points and different periods was the essential of the problem leading to eruption from a more or less horizontal position to a vertical one, and at last arranging the morsal surfaces of the teeth in a common occlusal plane. It was interesting to note that from an intensive study of occlusion at varying ages Friel had already deduced the forward drift of the teeth and noted the greater movement of those in the mandible. It was seen also that Professor Brash supported the view of the variability of the position of the first permanent molar, and claimed that the theory of "interstitial growth was founded on a misconception of alveolar bone growth." In dental literature the word "separation" was only used for spaces between teeth, and it led to some confusion of thought if this word was used in reference to maxillary width. With all due deference to other observers, Professor Brash included, the speaker had always claimed that the posterior surfaces of the second deciduous molars were not on the same vertical plane, and owing to the excessive curvature of this surface of the maxillary molar (under the gum at this stage normally) the erupting first permanent molar was given the desired trend towards normal occlusion. A widening of the arches would seem to be justified to the extent to which the labial movement of the teeth would have carried them under normal conditions, but it was impossible to say at present what this amount was for any individual case. Was it not possible

that here was the reason for the relapse of "over-expanded" cases? Professor Brash spoke speculatively of the possibility of labial movement of the maxillary teeth controlling the same movement of teeth in the mandible. It would be agreed by all that this movement was very often in evidence, but the rate of maxillary expansion must be correlated to the mandibular alveolar growth. As a matter of clearness to the text it would seem better when discussing the inclination of the molar teeth that the long axes of the molars were given the same directions as the morsal surfaces, that is to say, backwards and outwards and forwards and inwards—a small point that would doubtless be corrected later.

It could not be denied that Franke was unfortunate in superimposing deciduous and permanent arches for comparative study; it tended to confuse thought. The labial movements of permanent incisors did take place and they were in quite a different relationship to the nasal spine and other structures than the deciduous ones. According to Franke one visualised the permanent teeth as taking up a position behind the deciduous ones, if they were there, which they knew was not the case. It gave him great pleasure personally to see that Professor Brash supported their nomenclature committee, and used the term "cheek teeth," much used by Osborne, but derided by some American authorities. He concluded by saying with what avidity the *Transactions* would be read and re-read by earnest investigators if they continued to include papers of this type, which he was rash enough to prophecy would go far to blaze the trail towards the elucidation of many of the most intricate problems connected with the etiology of malocclusions and the ultimate elimination of these perversions by prevention or rational treatment.

Professor William Wright (London Hospital) said that Sir Arthur Keith had characteristically opened his remarks by an historical reference, and he might perhaps be permitted to do the same. He had spoken of Professor Brash's contribution as being the most remarkable which had been made to the subject of the development of the jaws and teeth. It would be rash for him (the speaker) to differ in that respect from Sir Arthur Keith, but he would like to mention the work of two other men, and he felt quite sure that Professor Brash would regard it as a compliment to be associated with them. One of the two was Eustachius, and the other was John Hunter. Eustachius was the first to distinguish between the milk dentition and the permanent dentition, and John Hunter's work, which of course would be familiar to all those present through Sir Frank Colyer's monograph, was also memorable. The work of these two men, together with Professor Brash's work, might be regarded as furnishing the greatest contribution to the study of this most important subject. Like Sir Arthur Keith, he had found great help from Professor Brash's summary, and so far as he had read the paper and summary he thought the only respect in which he differed from Professor Brash was in a phrase in the first part of the summary. Professor Brash said: "The alveolar growth is the main, possibly the sole, factor in the growth in depth of the body of the mandible and maxilla." The speaker agreed that it was the main factor, but he could not agree that it was the sole factor. He (the speaker) would argue that for the alveolar bone there must necessarily be a firm basal support represented by the compact bone of the lower margin of the body of the mandible, and he would infer that with the increase in the alveolar bone consequent on the progressive development of the teeth, there would be a *pari passu* increase in the strength and size of this support—an increase which would contribute something to the growth in depth of the body of the mandible. Professor Brash probably had some very good reason for his statement, but the speaker would like to question the advisability of using the phrase, "possibly the sole factor in the growth in depth."

Another point which was interesting to him, and might be interesting

to others present, was the very persistent character of morphological processes. If one went back, for instance, to certain fishes like the sharks one found the teeth coming forward and outward over the mandible in something like the same way in which Professor Brash had shown they moved in the human subject. To pass to much larger forms, in the manatee and the elephant, one got admirable examples of this forward movement of the teeth. He thought that the explanation which Professor Brash had given of the cause of eruption of the teeth, that there was a local intensification of the action of the osteoblasts in that region, was a satisfactory one, and he thought that it would be interesting to see the jaws of pigs fed on madder after certain of the teeth had been extracted. The growth of cementum and the rotation of the teeth in the sockets were also matters of great interest. One sometimes asked, like the man in the New Testament, for a sign from heaven, but if one were really looking for miracles it seemed to him unnecessary to look any further than the jaws and teeth of a child, say of five or six years of age. It was most extraordinarily impressive to contemplate these various osteoblasts acting, so to speak, like bees in a beehive or ants on an anthill, working unceasingly and with such wonderful accuracy ; because, in spite of what was often said to the contrary, it was by no means an uncommon experience to find a perfect set of teeth. And when one thought of all the actions and reactions which had taken place before that perfect set of teeth was produced, it seemed to him definitely that such processes were in the domain of the miraculous. One matter which Sir Arthur Keith had raised and which interested him was the question whether there was any growth at the sutural lines. Years ago he was present at the opening of a prehistoric barrow in East Yorkshire, from which he thought twelve skeletons were recovered. Seven or eight of them exhibited what was known as metopism—a suture in the middle line of the frontal bone. The two halves of the frontal bone had remained permanently separate. One noticed that in these skulls there was a much greater width in the frontal region than usual. The greatest transverse width of the cranium was as a rule in the neighbourhood of the parietal eminences, but here the bi-frontal width was very large, a condition which he was inclined to associate with the persistence of this metopic suture. He was aware that Professor Brash was working on acromegaly, and he thought it possible that by a study of the pathological conditions in such cases as acromegaly, even further light might be thrown upon the growth of the jaws and teeth. In conclusion he wished not merely to congratulate Professor Brash upon work which stood with the work of Eustachius and John Hunter, but also to congratulate the Society on being able to encourage and asist such extremely useful work as that which constituted the basis of this paper.

Mr. G. Campion offered his congratulations to the Society on receiving such a paper, and said that there were one or two points which seemed to him to require a little further elucidation. Of course, Professor Brash would hardly expect all of them to part with their prepossessions and prejudices at once. There was the question of the stable base of the mandible. The speaker did not quite feel able to accept what Professor Brash told them about that—that there was no such thing. He admitted of course, all Professor Brash's observations. He admitted that there might be no anatomical difference between the base of the mandible and the alveolar process. But if he asked for a definition the speaker would have to come to the terms of physiology and say that it was that part of the mandible which through life was kept in a continual condition of stress by muscular tension, so that what was an anatomical fiction might be a physiological and clinical fact. But that was quite a small point, and the point about suture growth was one which Professor Brash still had under consideration and was going to elaborate at a future date. The speaker was prepared to accept almost everything that Professor Brash told them in order to get on to the great things which he promised

them in the last paragraph—a complete rationale for dental practice. This part of his paper had been working in the speaker's mind and had even invaded his dreams. He dreamed that Professor Brash placed one day in his hands a pair of dental arches ; that the units of these arches were perfectly proportioned the one to the other, and the arches were perfectly formed according to the data which he had been able to amass. He found to his delight on placing them in occlusion and moving them in articulation, that he had in his hands visible and tangible expression of the very highest imaginative conceptions of Mr. Friel. Then Professor Brash presented him to a face which, as he looked at it, seemed to have great elements of beauty but to be strangely wrong in some way, and he told him that this was a face devoid of dental arches, and that these two dental arches which he had placed in his hands were perfectly proportioned to the face, and he invited him to put them in their proper places. His (the speaker's) reply was that this was not one of his usual jobs, and that he would have to ask for the co-operation of others. Therefore he invited Mr. Badcock, Mr. Northcroft, Dr. Sim Wallace, Mr. Rushton, Mr. Chapman, and Mr. Friel, and they all met and considered the matter. Ultimately they came to a general agreement and placed the arches as they thought proper. Then they presented the result to Professor Brash and to another gentleman who came into the room and whom Professor Brash introduced as an eminent sculptor—they rather guessed it was Epstein, and so it proved. They invited Epstein to examine their work and to say what he thought of it. He studied it with deliberation from different points of view, and after a prolonged examination he expressed the opinion that they were wrong ! That, of course, opened the way for a discussion, and a discussion ensued. He need hardly tell them that with such a galaxy of talent on one side and the genius and knowledge of Epstein on the other, the discussion was very illuminating. He wished he could give the Society an account of it, but that was impossible. He could only say that for brilliance, dialectical subtlety, and general inconclusiveness it might have extorted the admiration of the ancient Athenians ! Well, Epstein's point of view was this, that they had placed the arches not quite far enough forward. He said that the face was not fully developed ; that they had placed their small system of relativity in a wrong position in regard to his larger system of relativity ; they had spent their lives studying the arches, while he had spent his life studying the face, and he said that they had put their units wrong. Who was right and who was wrong must remain among the enigmas of dreamland, but, speaking to men concerned in the practical application of this matter, he submitted that this problem with which they were faced was child's play compared with some of the problems which faced them in treating these cases in ordinary practice, especially in hospital practice. They found themselves confronted with cases in which the face was deformed, the arches deformed, and the arches having teeth altogether disproportionate to the size of the face. They found also arches decimated by caries, and when he personally found himself confronted with a case of that sort it did not help him to be told, " Oh, it must belong to class 1, or class 2, or class 3," and that one had only to decide which it was and prescribe the proper treatment. That reminded him of a story of paleolithic man. It was that the zoologists of that period used to classify the animals according to the respective length of their legs and their tails. If their legs were equal to their tails they were put in class 1, if the legs were longer than the tails, in class 2, and if the tails were longer than the legs, in class 3. In succeeding ages the zoologists had learned that this system required very considerable modification. He believed that in time to come the knowledge which Professor Brash was giving to them, and which they were slowly accumulating with regard to the growth of this larger system of relativity-entire face, would alter their classifications in orthodontics and would lead them to one which would enable them

to apply with more precision and discrimination than they could at present the recent and brilliant contribution which Mr. Chapman had made to the etiology of the subject. He thanked Professor Brash for his paper, and suggested—a thing which Professor Brash probably already had in mind—that the madder experiments might be applied to, if not the anthropoid apes, at any rate to some forms of monkeys. This would add to their knowledge on the question of sutural growth to which Sir Arthur Keith had referred, and would bring the whole subject more within the conditions in which they had to deal with it in practice.

Mr. SHELDON FRIEL said: I should like to join in thanking Prof. Brash for his paper. He has elucidated the manner in which the changes in the jaws and the relations of the teeth have taken place which have been very perplexing to us practitioners. Recently at the International Orthodontic Congress in New York I read a paper on occlusion and the changes which take place from infancy to old age, and I was very glad that Prof. Brash has confirmed many of the points that I had brought out in that paper. The first two lines in Prof. Brash's fourteenth summary are, "The general conclusion is that the alveolar arches are in a constant state of change." I used very similar words in the beginning of my paper in reference to occlusion—that it is ever-changing. I will try to show that the changes in occlusion are very similar to the changes that Prof. Brash has shown in the alveolar bone.

In the first slide, a drawing of the occlusal surfaces of the lower teeth with the outlines of the opposing teeth, the points and ridges of the cusps of a child of 3 years of age, you see a definite occlusion, which is made all the more definite by the length of the cusps, sharpness of the ridges and the depth of the fossæ and grooves. Now between this age and about 6 years of age a great change must take place. Space must be provided for the permanent incisors. On an average the upper permanent incisors are nearly 8 mm. wider than their predecessors, while the lower permanent incisors are only 6 mm. wider, so that if no other change took place the lower arch would retrude in some direction behind the upper arch. Prof. Brash has shown in his madder-fed pigs that the lower teeth are moved in a proximal (medial) direction a greater distance than the upper teeth. I came to the same conclusion from the examination of models of the same children at different ages, and that this forward movement of the lower teeth compensated for the greater increase in the size of the upper arch. The next slide shows the deciduous teeth worn, so that the cusps are almost flat, and that the buccal groove of the lower second deciduous molar is medial to the medial buccal cusp of the upper second deciduous molar. In order that this greater forward movement of the lower teeth may take place two conditions seem to be essential: first, a greater lateral expansion of the upper deciduous arch compared with the lower arch, so that as the lower arch comes forward the lower deciduous canines and molars will not occlude buccally to the upper deciduous canines and molars; and secondly, an attrition of the cusps and fossæ of the teeth, sufficient to allow of the lower teeth sliding forwards. The next slide shows a case of a similar age without wear of the cusps of the teeth. No forward movement has taken place, and there is an apparent protrusion of the upper incisors. I think that the cases we see of almost normal occlusion, but with a marked overbite of the incisors, must start with the want of forward and upward development of the molar region.

The next major change in the occlusion is after the loss of the deciduous canines and molars. On an average, the difference in the combined medio-distal diameter of these teeth is 1 mm. in the upper arch and 2 mm. in the lower arch, so that in both arches too much room is provided. In the upper arch this space is reduced very slightly, and in the best developed arches that I have seen a space is found between the canine and lateral incisor. In the lower arch, on the

other hand, the first permanent molar drifts forwards, and one gets the triangular ridge of the medio-buccal cusp of the upper first permanent molar more definitely in the buccal groove of the lower first molar. The next two slides show the forward movement of the lower first molar.

Prof. Brash has referred to the time that the movements of teeth cease, and he seems to consider that it ends with the eruption of the third molars. A change in the relation of the lower to the upper teeth does occur in old age, but I think it is associated with wear. In primitive races and early man the lower arch does come forward in relation to the upper arch when the molar and premolar teeth are greatly worn. This mechanically allows the lower jaw to swing more forwards and upwards, and consequently the lower incisors wear more heavily on the upper incisors and the cutting edges are worn away, producing the edge-to-edge bite. We are all very much indebted to Prof. Brash for his work.

Mr. Wilson Charles said that he was sorry that he had omitted to notice the reply in the *British Dental Journal* to the paper which he wrote some time ago on madder feeding. He felt that on this occasion he need not refer to the madder method, not, perhaps, because he could not reply to what had been said, but because he found himself so nearly at the same conclusions which Professor Brash had reached, that instead of arguing about the subject he was able to support him whole-heartedly. The first point to which he would like to draw attention was the fact that the first permanent molar was not a fixed point. The way in which he had arrived at that conclusion was somewhat different from that taken by Professor Brash. It was set out in the paper which he read at the annual meeting of the British Dental Association, when he described his conception of how the growth of the jaw took place, how the condyle pushed the lower jaw forward and the teeth grew up in that direction. That, apparently, had given rise to the idea that he regarded the mandible as a long bone, but in fact he had no such idea. The growth of the body of the mandible took place in one direction, and the condyle in another direction, not in one continuous line, and the erupting teeth were coming forward so that one had the gradual uprising of the alveolar bone.

Sir Arthur Keith asked whether the speaker held that there was no movement in the coronoid process at all.

Mr. Wilson Charles replied that there was a certain amount of absorption, but that was not the main way in which the process was moved. The only other point on which he had to speak was Professor Brash's last statement that " the importance of these conclusions, if substantiated and accepted, in providing a conception of constant change in the arches and constant movement of the teeth in the arches during their development, cannot be exaggerated." It appeared to him to be definitely certain that the conception which Professor Brash had brought forward was the correct one, and he could only say that he would like to join heartily in the congratulations.

Mrs. Lindsay said that she rose with great trepidation to take part in the discussion with so many distinguished authorities, more especially because one by one most of the points which she had had in mind had been dealt with. She had been reading a paper by Sir Charles Tomes, written in 1885, on the re-formation of bone, and it seemed to confirm what Mr. Campion had said that evening. The paper by Sir Charles Tomes mentioned an interesting case, in which not only was the entire body of the mandible re-formed after excision, but also the alveolar bone grew up round the teeth which had been left to the mucous membrane. The specimen was in the Bellevue Hospital Museum in New York at the present time. There was also a case treated by Sir Charles Tomes himself for syphilitic osteitis of the mandible, where the alveolar bone was entirely swept away and the basal bone, which remained healthy throughout, was left. That seemed to suggest that

not only in respect of elasticity was the alveolar bone different from the rest, but also in susceptibility to disease. It reminded one of Metchnikoff's point that the parts so susceptible to disease were disharmonies to the whole organism, and Metchnikoff noted the teeth as a disharmony. Professor Brash had said that the alveolar bone was continued into the coronoid process. She had had great difficulty for many years in understanding a case which was illustrated in Sir Frank Colyer's book, of the eruption of a wisdom tooth into the notch between the coronoid process and the condyle. Professor Brash spoke of the lower wisdom tooth in its crypt, and in course of eruption coming down into the jaw, apparently in the opposite direction, to eruption. Could it happen that instead of turning down towards the body of the jaw the tooth in this case had turned up into the ramus, and how did he explain it travelling right up to the notch, the ramus having been formed before the bony crypt of the tooth ? In conclusion she would like to thank Professor Brash for the abundant food for thought which he had provided from his first Dental Board lecture until now, and to express her great admiration for the beautiful specimens by which his paper had been illustrated.

Mr. Robert Lindsay also joined in the appreciation of Professor Brash's paper. The paper had made him think, and, happily, the more a man thought, the less, usually, he felt inclined to speak. He was driven back upon Professor Brash's Dental Board lectures, and from there by a natural process to the work of Franke. He thought that in the Dental Board lectures Professor Brash had laid down the line of development which might naturally be expected, and the further investigation upon which the present paper was based indicated the point which had now been reached. There were one or two differences. If he remembered aright, the cutting back of the coronoid process was rather more emphasised in the Dental Board lectures than it was now. But even then, the movement of the teeth forward in the jaw by deposition of bone in the alveolar sockets was postulated, though there was at that time no evidence to support a positive statement. Franke's thesis, as they would all remember, was based upon the immobility of the first permanent molar, and it was no disrespect to that very remarkable man, whom one admired more the more one read of him, to recognise that he made a mistake, and that Professor Brash appeared to have demonstrated quite clearly that there was no such thing as a fixed point with regard to the first permanent molar, or, as Sir Arthur Keith had suggested, anywhere else in the organism. Franke, he imagined, fell into error by devoting his investigations almost entirely to the measurement of dried specimens, whereas Professor Brash had employed the vital method of investigating the problem. One felt that Franke overlooked the extraordinary activity going on in the growing jaw of the young child, well likened by Professor Wright to the activity of a hive of bees. Considering the whole thing as a measurement of dead materials, Franke was led into error. He (Mr. Lindsay) agreed with Mr. Campion : they had always been led to associate the alveolar process intimately with the teeth and to expect that when the teeth were lost the alveolar process would be lost also, while the jaw still continued to perform to a certain extent its functions. It was a little difficult for them to conceive that the whole of the important growth with reference to the lower jaw was concentrated upon the upper margin. But, like Mr. Campion, after full consideration of the various points in the paper, with which he would not attempt to disagree, he came back to the conclusion that the great matter of interest for a society like this was its effect upon the future practice of orthodontics. He had listened in that Society to a number of very interesting and very important communications, and he had had the opportunity, as also had some other members, of hearing and seeing in America some of the results of interference with the teeth for the purpose of regulation. These results, he thought, must impress them

with the possible danger of injudicious movement of the teeth, and he hoped it had impressed them also with the feeling that the great line to follow in the future would be what might be called preventive orthodontics. Professor Brash's paper supported that view.

Professor J. C. Brash, in replying, on the whole discussion, said that his first duty was to thank most warmly all those who had taken part for the very kind things they had said about his paper. Some very high compliments had been paid him. Professor Wright had reached almost the high-water mark by associating him with Eustachius and John Hunter, but Mr. Lindsay had even surpassed this by saying that he (Professor Brash) had made him think!

He would like also most sincerely to thank the Society for the opportunity which had been afforded him of bringing forward this work, and for the honour they had done him in devoting two whole evenings to his paper and to the discussion. Many points had been raised in the course of the discussion, and he was afraid it was not possible for him to deal with them all, so he would just go through his notes and take them as they arose. Sir Arthur Keith started with the historical view and told them about the discovery of madder feeding by Belchier. He did not discuss that in his paper, because he had previously done so in his Dental Board lecture. He had been investigating the origin of the staining of bone by madder, and he found that it was in fact well known in ancient times. There were some classical references to this property of madder. One of the chief points that Sir Arthur Keith had made was whether these results in pigs could be transferred to the human subject. That, of course, was a question for further investigation. What he hoped to do next was to attempt to apply the results which he had got in the pig to the human jaws and skull, and there, of course, since as yet they were not able to apply the vital staining methods to the human bones, would come in the importance of that great series of measurements which Sir Arthur Keith and Mr. Campion gave in a paper to that Society some years ago. Sir Arthur Keith had mentioned the lower border of the mandible; he seemed to agree that there was very little growth on the lower border of the mandible in the pig. Whether this was so in the human mandible he (the speaker) could not say, because he had not yet got to the stage of applying these things in detail. He thought that Professor Wright subsequently referred to the various theories relating to alveolar growth, but perhaps he (Professor Wright) had missed the point that the growth upon the lower border of the mandible in the pig was a growth which was associated with the travelling back of the preangular notch. As the preangular notch travelled back there was an addition of the bone on the lower border which filled that up and replaced bone which had previously been removed. He thought probably it would appear that the same thing was applicable to the human mandible, because in the human mandible there were the same variations which he had observed in the pig. But these were points he had not yet investigated.

So far as the growth of the sutures was concerned, he must leave the discussion until a future occasion. Both Sir Arthur Keith and Professor Wright had mentioned this point and had perhaps tried to draw him a little. All he would say was this, that all the evidence against his view that Sir Arthur Keith had suggested—the changes in the form of the skull associated with the closure of cranial sutures and so on—could be equally well explained on the other view that there was no separating growth in sutures. If surface growth had ceased in a particular direction then the sutures in relation to that direction might also close. It was no proof that there must be growth in sutures to show that a particular form of skull was associated with the closure of sutures in a particular direction. Mr. Campion, so far as he could follow his excursion into dreamland, made the point—and a very good point it was too, and one which he with Sir Arthur Keith

was responsible for calling attention to—that the growth of the jaws was only one part of the growth of the skull. But this particular paper was concerned with only a part of the growth of the jaws—the growth of the alveolar bone—and he thought he had indicated in references to the lower border growth and coronoid growth and to the question of suture growth, that the alveolar growth could not be considered by itself. This was undoubtedly only a part of the much larger question of the growth of the skull as a whole, and he did not think they would be able completely to understand the changes even in the alveolar border, and particularly the factors that conditioned those changes, until they did have a more thorough knowledge of the growth of the skull as a whole. The further line along which he hoped to work was this growth of the skull as a whole. Circumstances being what they were, he had devoted a great deal of attention to the alveolar bone, which was of particular interest to orthodontists, but in future he would give the alveolar bone a rest and would go on to the wider question, and then he might be able to come back to the alveolar bone again with further evidence which would help to place it in its true relation to the growth of the skull as a whole.

Mr. Campion had suggested that it might be possible to apply the madder method to some of the monkey tribe. This he had already arranged to do. He was beginning now to feed a number of monkeys on madder, but as yet he did not know whether madder would colour the bones of monkeys or not. There were some differences in the actual effect of madder on the bones of different animals. The bones of the rabbit, for instance, were extremely difficult to stain with madder, and it was quite on the cards that the bones of monkeys would not stain. In the whole history of madder—and madder was used for many years in the pharmacopœia for all sorts of complaints, generally as an " alterative "—there was no record of any evidence of the staining of human bones by madder. What the reason for the difference was they did not know, whether it was a difference in metabolism or in the absorption of madder. One thing was pretty obvious, and that was that the different constituents of madder—this again was rather away from the main subject of his paper, but it was of interest—affected the bone in different ways, and purpurin was a much more powerful constituent than the other main colouring principle, alizarin, which was found in the madder root. It might be, therefore, that the monkey experiments would fail unless purpurin could be got into the animals by subcutaneous or intramuscular injections. He had been particularly interested in what was said by Mr. Sheldon Friel, who sent him a copy of the paper he read in America some time ago. He had had great difficulty in getting through the technical terminology, but he was glad to learn that there was a definite relation between this work which he himself had undertaken solely from the anatomical point of view to begin with, and the practical work of the orthodontist. Mr. Northcroft also referred to the paper from that point of view. He had, however, carried out the work entirely as an anatomist, and he held very strongly that work of this kind must in the first instance be done for its own sake, with the aim of finding the truth of these things, whatever the application might be to practice. But if the application to practice came along—the reward for having done the work would be so much the greater.

Mr. Wilson Charles very kindly said that he felt able to agree with him on most points, but left aside the question of the technique and the discussion of the madder method. The short reply which the speaker had written to the *British Dental Journal* had not yet appeared; probably it would appear in the next number, but he was quite sure that whatever difference had arisen with regard to the interpretation of the madder appearances, there was a fundamental agreement between the view which Mr. Wilson Charles had described regarding the growth of the mandible from the condyle and the view which he (the speaker) had

suggested, but not yet discussed in detail, as to the actual amount of absorption that took place in front of the condyle. He agreed with Mr. Wilson Charles on that point, and their previous disagreement having been brought into the open, would, he trusted, now end. It related simply to the interpretation of the madder appearances in the specimens. One last point raised by Mrs. Lindsay was with regard to the base of the mandible being something permanent. This he could not believe, because the evidence was present in the specimens that there was nothing absolutely permanent in the mandible or in any part of the skull either during its growth or after the main growth had ceased. One thing of which he was convinced was that every part of the jaw was in a constant state of change, and he could not but believe that these changes were due to functional reasons; that whatever might be the conditions under which bone grew and was absorbed, some part must be played by changes in the function and by changes in stress for whatever reason. He could not believe that there was any point anywhere at all in the body constant and unchanging throughout the whole of life. This applied not only to the period of growth but even after full growth had been attained. Later in life there were changes in the jaws as elsewhere. Age changes were growth changes in another sense. Bone was plastic always, and in a constant state of change, and what they had to deal with was not something permanent, permanently holding the teeth in position, but something always changing in itself and therefore capable of alteration under the conditions which might be induced by their appliances for the regulation of the teeth.

Mrs. Lindsay had asked a question about the position of the molar in the sigmoid notch. He would suggest that that molar had reached the sigmoid notch in the same way that the canine tooth might find itself in the middle of the palate, which was a fairly common condition. He did not know what caused the bone to push the tooth up into that position, but the mechanism would be that instead of coming forward the tooth would be carried upward into the sigmoid notch.

The PRESIDENT proposed a vote of thanks to Professor Brash and to the other speakers in the discussion. The paper had been an epoch-making one, and the discussion had been worthy of it, and quite possibly would influence orthodontic thought all over the world.

The vote of thanks was carried by acclamation.

AN ordinary meeting was held at 8 p.m. on Monday, November 1st, 1926. The chair was occupied by the President (Mr. G. F. CALE-MATTHEWS).

The minutes of the last meeting were read by the Secretary and confirmed.

The following candidates were elected to membership of the Society on a show of hands: Mr. B. M. Shaffner, D.D.S.Dalhousie, L.D.S. R.C.S.Eng., 41, Wimpole Street, London, W.1; Mr. D. H. Campion, B.D.S.Manchester, 264, Oxford Street, Manchester; Mr. H. L. Power, L.D.S.R.C.S.Eng., 270, Earl's Court Road, South Kensington, London, S.W.5.

ORTHODONTICS AND COMMON SENSE.*

By Wm. Rushton, L.D.S.

Having been requested by your Honorary Secretary to read a paper before this Society, of which I have the honour of being one of the founders, I have much pleasure in complying with his wish.

In 1914 I read a paper before the sixth International Dental Congress, held in London, entitled "A Criticism on the 'New School' of Orthodontics," in which I endeavoured to show that the claims made for the new school were in many cases unreasonable, and advocated dealing with dental irregularities in a rational manner, whether by extraction or expansion or a combination of both. I pleaded that each case should be judged on its merits and no hard and fast dogma should be placed as a burden on the back of the practitioner. Since that time I am more than ever confirmed in my views and these views I shall repeat in certain parts of this paper. I showed that the theory of the new school rested on the ideal of perfect natural occlusion—the full complement of teeth in normal relations. To extract a tooth was in their view to practice mutilation—an offensive term as well as an incorrect one—one might just as well describe as mutilation the removal of the appendix or tonsil—and the practitioner who extracted a tooth for regulation purposes was branded as an "odontocide." We may smile at this sort of thing, but it has undoubtedly influenced many practitioners by persuading them that such extractions were morally wrong, amounting to malpraxis. The only justifiable practice in their view was so to enlarge the alveolar arch that space would be made for the full complement of teeth.

The argument of the American school, I take it, is as follows: Nature has endowed mankind with sixteen upper and the same number of lower teeth which interlock in a particular way. They say that it is our duty to preserve these thirty-two teeth at all costs, and not only to preserve them but to take such measures that all the cusps interdigitate in the correct manner.

Now, it is true that nature has provided man, at the present stage of the world's evolution, with thirty-two teeth. We are told that in the remote past the number of teeth was greater. How do we know that the process which has eliminated some of those teeth and diminished the size of the jaws is not still going on? We have certain reasons to suppose that it is. Jaws are growing smaller and the third molar has commonly too little room to erupt. The mandible especially seems inclined to diminish in size, and so frequently does this occur that many are of opinion that this condition may have to be accepted as a normal one. Mr. Norman Bennett has said, "I am inclined to think that the time will come when it will be accepted that the jaws of civilised man are no longer capable in many cases of holding the full complement of teeth, and that the extraction of four first premolars before or after eruption will be a common operation. There can be little doubt that inferior retrusion is becoming more frequent and that the mandible is diminishing in size at a greater rate than any other part. It is possible that postnormal occlusion of the lower

* *Transactions*, Nov. 1st, 1926.

arch to the extent of one unit will come to be accepted almost as a variety of the normal and as being not less beautiful."

How rapidly the jaws may diminish in a comparatively few generations is shown by the condition of the jaws of the American negroes, in which people the jaws, in a matter of 300 years, have altered from the prognathous condition of their forefathers to one approximating the white standard. Therefore when we are told nature intends us to have thirty-two teeth, I ask why does she not find room for them? We know something of nature's working in the past and the present, but her "intentions" are unknown. We can only take her as we find her, and tackle her problems as best we can.

As regards the second point, that of function being adequate only when the articulation is normal, I ask for proof. I know of a large number of cases in which function is perfect under abnormal conditions, not only in the case of the postnormal bite aforesaid but also in cases of regulation by extraction.

The American school, having started from what I consider an untenable premiss, have followed up their theories with logical precision, and by their industry and enthusiasm have carried away many of the dentists all over the world, so that to differ from their standard is tantamount to acknowledging oneself hopelessly antiquated. The consequence is that children are wearing complicated appliances, which may do the teeth and gums great harm, for a long period at a great expense, when, in a great many cases all these evils could be avoided. Such practice can only be excused on the plea that it is the only proper treatment. We do not, like the physicians, swear the Hippocratic oath, solemnly affirming that we will always place our patient's welfare before our own interests, but I have no doubt we have a desire to do what we consider best for those under our care.

Are we doing our best when we condemn a child to long years of treatment when by extraction we can simplify the case? The keynote of the American system is occlusion; correct occlusion must be obtained at all costs or dreadful things will happen. Dr. Angle says: "In proportion as malocclusion exists the function of the teeth and speech are impaired and the facial lines marred." This is by no means always the rule. We meet with cases when the occlusion is normal but the facial lines are marred by the arches being too narrow and the front teeth consequently too prominent. On the other hand, we often see cases in which malocclusion exists where the facial lines are harmonious and beautiful. So that Dr. Angle's statement that "the effect of malocclusion upon the facial lines is always to disturb their balance and harmony, and this in direct proportion to the extent of the malocclusion," though sometimes true, is by no means always borne out by facts. In my opinion Dr. Angle confuses cause and effect; the cause of the deformity may be varied, such as mouth-breathing, thumb-sucking, traumatic injury, etc., and one of the effects of these may or may not be malocclusion. The greater the maldevelopment or deformity of the facial bones, the greater will be the probability of malocclusion, which is only one incident in the general malformation.

The function of teeth is, chiefly, to masticate food, and I maintain that any set of teeth which is regular enough to maintain facial

FIG. 1.—Models of a girl aged 10½ years, where there was post-normal articulation. She was a lip-biter. The model 18 years later was also shown. They could see that the first premolars had been extracted; there was not normal articulation, but it was a good functional bite, and she had been made into a good-looking girl. The case took 1½ years.

FIG. 2.—Shows the girl before and after treatment. In the first she was drawing her lips together to hide her teeth, which were very prominent; in the second, after 18 years, they could see a very pleasing result.

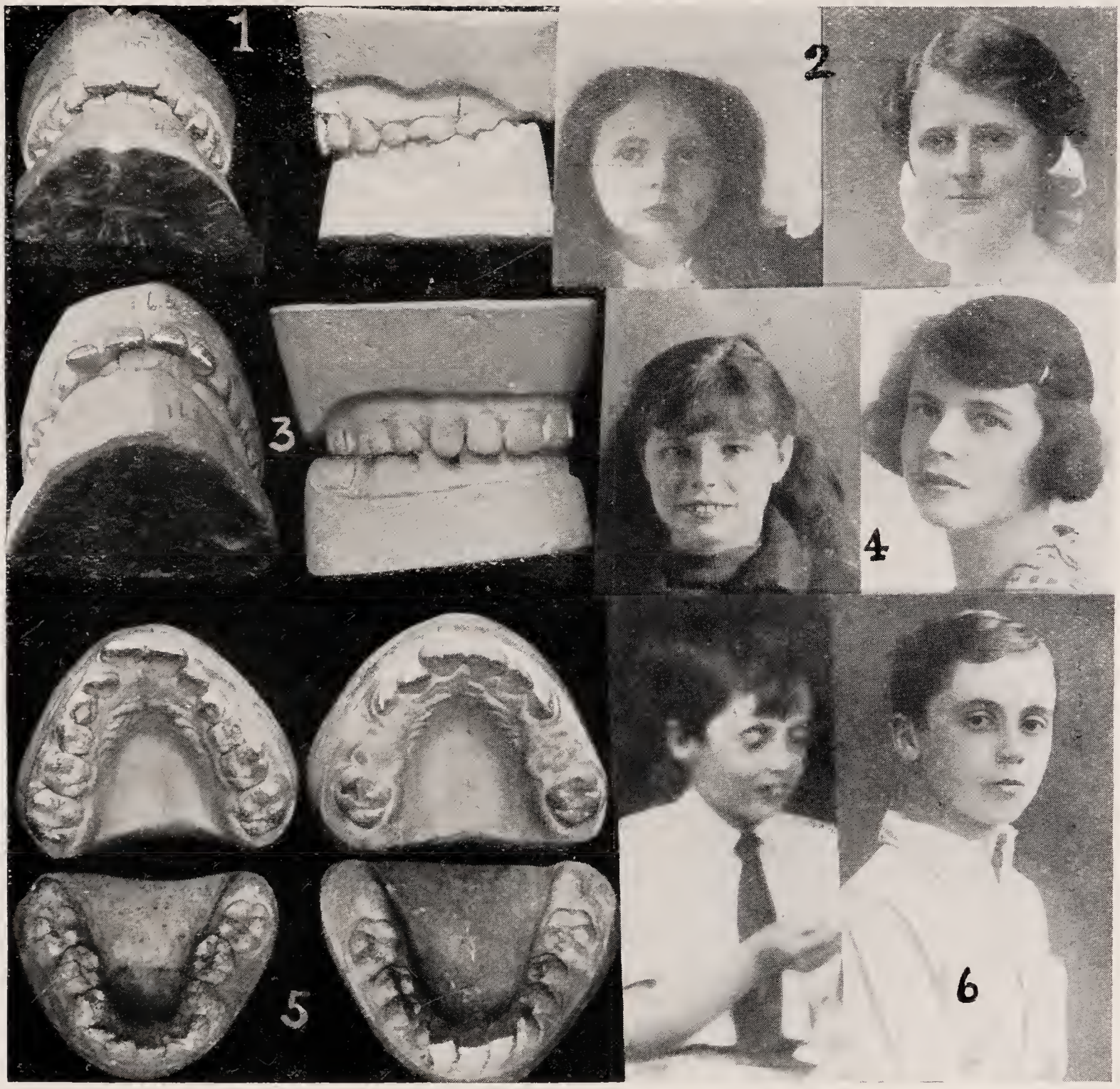


FIG. 3.—The case of a girl aged 11 years who was a thumb-sucker. They could see how the lower incisors bit against the uppers. He extracted the two lower first premolars and brought in the lower incisors sufficiently to allow him to work on the uppers. Subsequently he extracted the upper first premolars and brought back the upper front teeth. Regulation took one year. The model 13 years later was given; he did not say that it was absolutely perfect, but it was a very good result from the point of view of regularity of the teeth and of function.

FIG. 4.—The girl before and after treatment.

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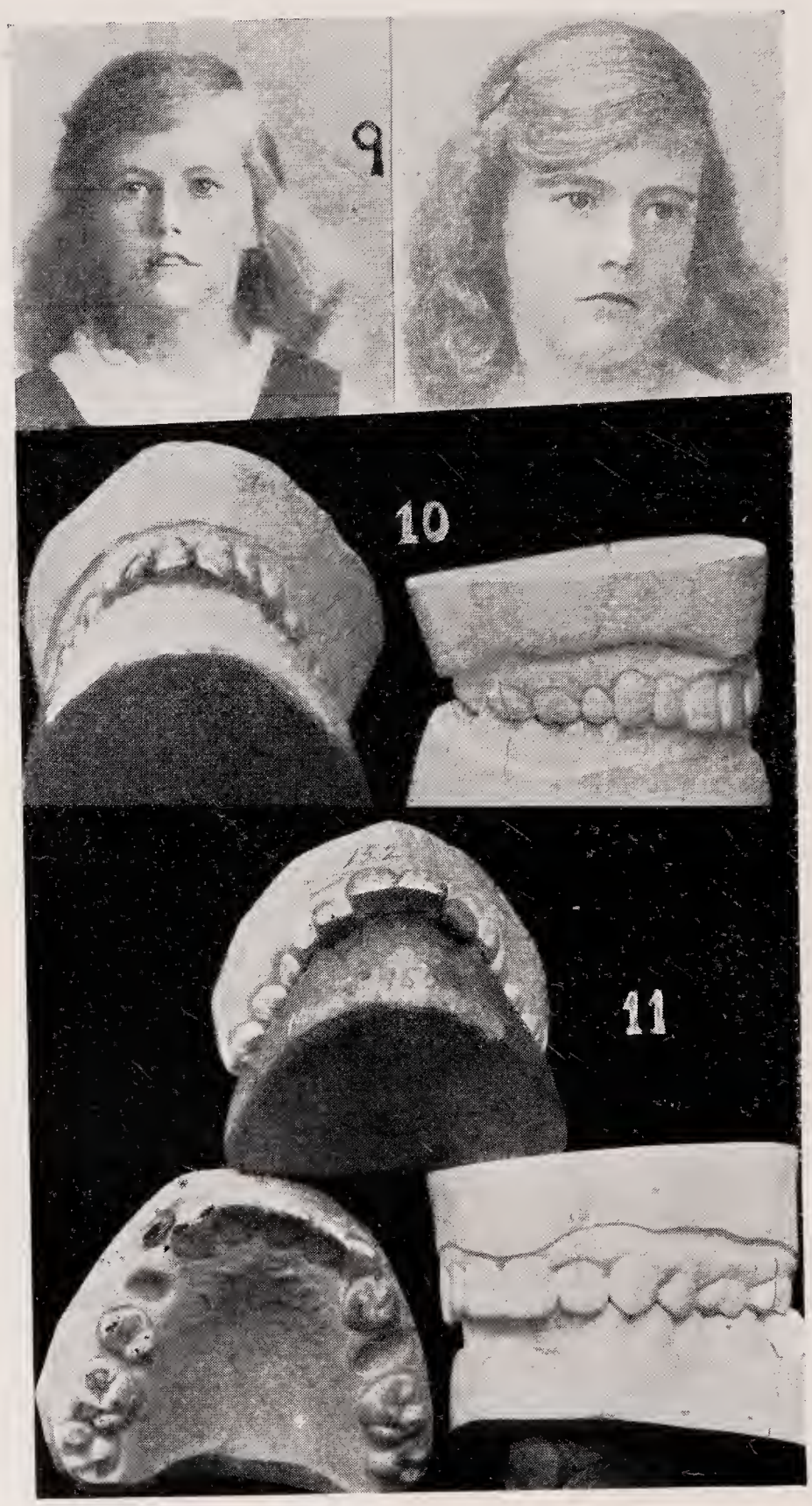
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Fig. 5.—A delicate boy. They could see how very undeveloped the mandible was. That of course had to be expanded, which was done with a Badcock screw-plate. Subsequently the upper was expanded. The later models showed how the case had improved, but unfortunately the case was never finally completed, as the little chap died of pneumonia. This case took a very much longer time—about 3 years. He first expanded the lower arch, put in a retention plate, and started expanding the maxilla, afterwards extracting the two upper fours and the lower left lateral. It was very crowded in the lower.

Fig. 6.—Photograph of above case was a snapshot; it is not a very good slide, but the marked difference in the boy could be seen.

Fig. 7.—A girl of 11 years and 4 months who had had her tonsils removed. She had also been a thumb-sucker. She had been bottle-fed, but he did not attach any importance to that, provided she had been properly fed. Some of the best teeth he had ever seen were of children who had been bottle-fed. The reason he thought it was wise a child should be breast-fed was that it had a better chance of getting clean food. The bottle was often improperly cleansed from one feed to another, so that the child was therefore being continually poisoned. He extracted the upper fours and brought back the fronts—that took one year. He was quite satisfied that the second model 14 years later showed a good result.

Fig. 8.—The girl before and after treatment.

Fig. 9.—Another similar case. The teeth were pinched in and prominent. The difference after treatment could be seen.

Fig. 10.—A case in which there was considerable space between the superior incisors. Some little time before starting the articulation of the case he brought the incisors together, then extracted the upper fives. Sometimes he extracted fours, sometimes fives, it depended upon several factors which had to be taken into consideration. He did not think it made a great amount of difference which were extracted, but if there was any likelihood of a space being left, although it took a little longer, it was sometimes wiser to take out the five rather than the four. The case shown was one where, for some reason, he took out the fives. The articulation took one year. The model 17 years later was given.

Fig. 11.—The author had resolved to do this case by expansion, for which he thought it was suitable. After he had expanded, to his horror and dismay he found that the canines came down outside and he was sorry he had not extracted in the first instance. Of course, afterwards he extracted (4 on one side and 5 on the other) and after three years finished the case. The models 10 years later after completion could be seen.

FIGS. 12 and 12A.—The girl had a crowded upper and lower. The two lower fours were extracted and the lower fronts brought back. After that she went to another part of the kingdom, and another practitioner treated the upper by expansion. A year later she came back as bad as ever, and he then extracted the upper fives. The second slide showed four years after completion.

FIG. 12B.—Shows the girl.

FIG. 13.—No history of adenoids or tonsils could account for this. Treated it by expansion. It took two years, and the model shown was taken 9 years after it was finished. The centrals were now working a little forward, and he hoped it was not going to get worse.

FIG. 14.—The girl before and after treatment. They could see what very prominent teeth she had had.

FIG. 15.—Case of a child that had been operated upon for adenoids. She had a very crowded mouth with very prominent lower canines, so he took them out, and had never regretted it. The case took two years. The model was taken 18 years after the regulation was completed.

FIG. 16.—This was a case of extraction only, and no other treatment. The two upper fives were extracted and the teeth came down pretty regularly. The bite was not perfect but was good enough.

Fig. 17.—A case still going on. Last April the author extracted the four 4's. The girl had now gone abroad for a year, and he would be very surprised if, when she came back, the bite had not arranged itself, or very nearly so. In a case like that, a child could go away, and there was no trouble—she could enjoy herself, her teeth would go on just the same. There were no visits to the dentist, no plate or appliance to keep clean, no risk. It had manifold advantages.

Fig. 18.—A girl with absence of one permanent lateral, the other being small. He extracted the latter and brought the canines forward. He was working on the other teeth to fill up the gaps, which no doubt would have been done, but the child died.

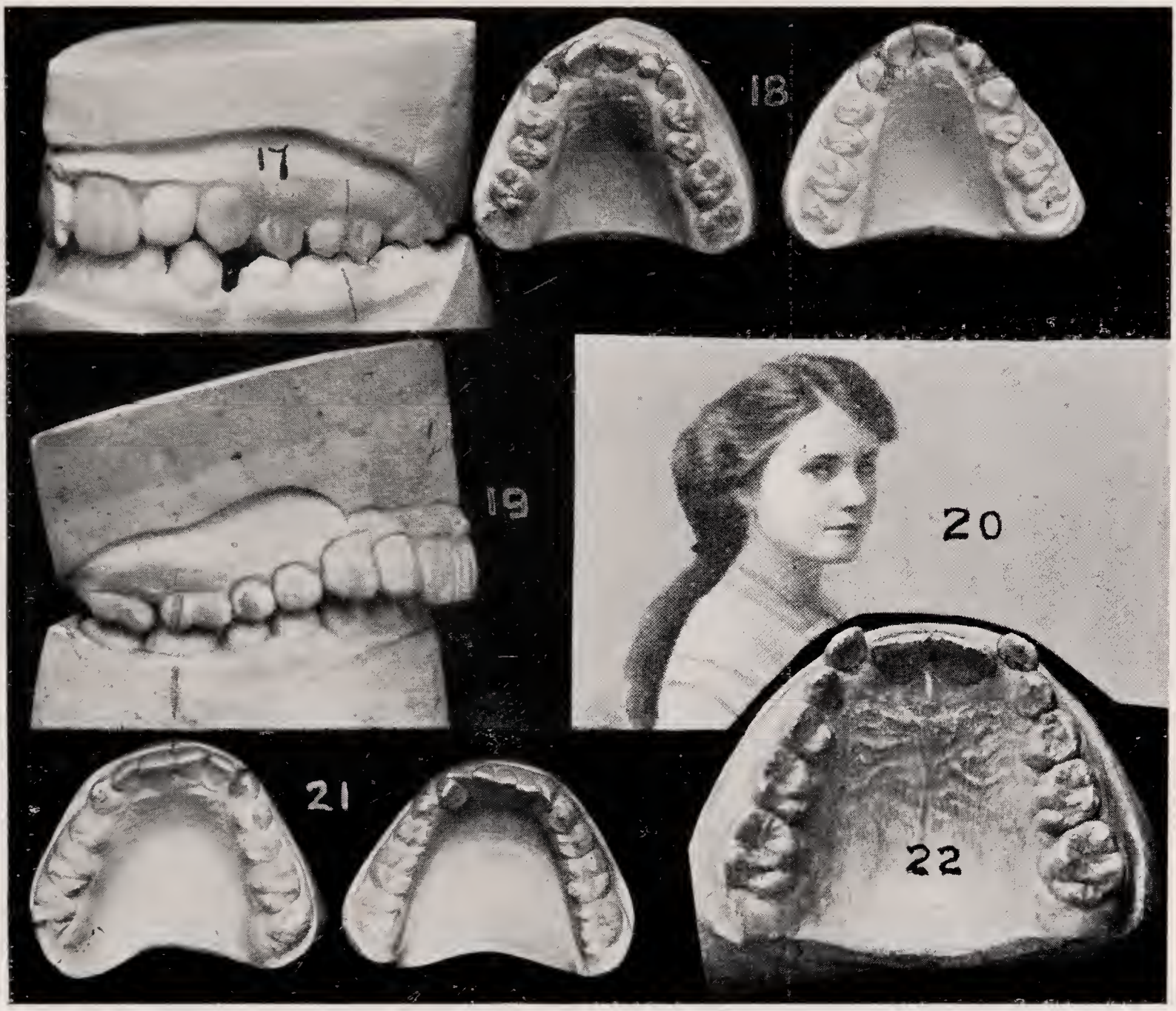

Fig. 19.—Here was one of those cases mentioned by Mr. Norman Bennett, viz. a natural post-normal one. He had done nothing to that, as he did not think it was called for. She had got a functional bite, and the teeth were fairly regular. His conclusion was to leave her alone.

Fig. 20.—Recent photo of the girl.

Fig. 21.—A case which showed that he was a man of very weak character! He felt it his duty to extract the two upper first premolars, but the mother strongly objected. There was an outstanding first premolar, and she said she only wanted that tooth extracted. He was weak enough to give way, but they could see the result, which however would only be detected by an expert. There it was, however, and it was not pleasant, it was lop-sided. If he had taken out the two premolars those teeth would have become very regular and would have been a pleasure instead of a disappointment.

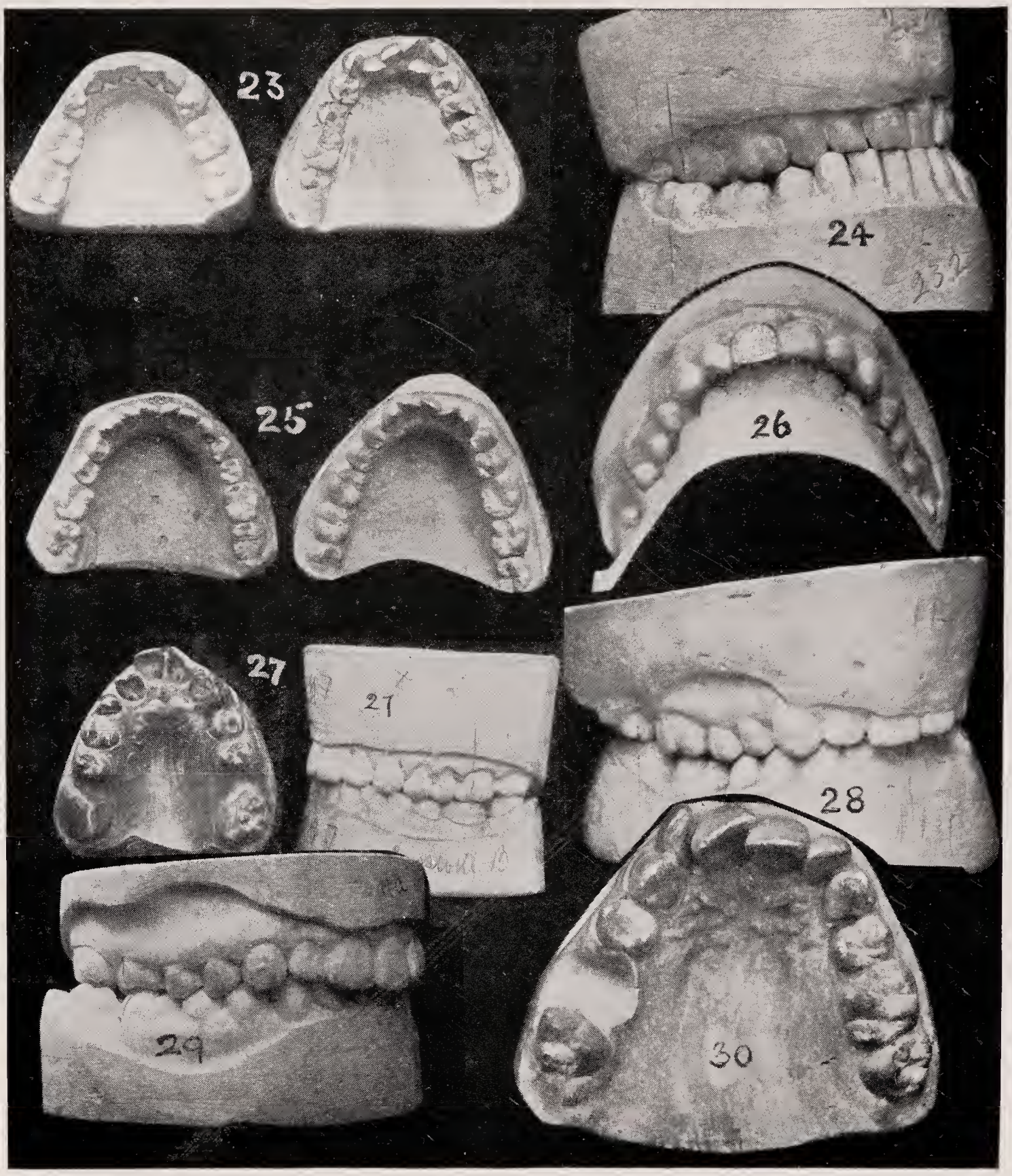
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Fig. 22.—Beware of laterals—they were very curious things. Here was a case which came to him when he was first in practice, and he went round to several of his orthodontic friends, and they told him to get those laterals back and nature would effect a cure. Nature does not effect those cures. He always looked upon laterals with very great suspicion. The canines were quite honest straightforward fellows compared with the laterals. He brought those back, but somehow or other the boy went away, or did not wear his appliance, and those teeth went back again just as badly as ever. By the time he had cut his wisdom teeth they were worse than ever. If a premolar had been extracted on either side all would have been well.

Fig. 23.—A case in which extraction was absolutely asked for. In cases like this they might be quite sure that they got the quickest and best results by judicious extraction. The case was also shown more or less completed. He extracted the right lower lateral and the two lower premolars.

Fig. 24.—Here was an extraordinary case. It was not one of his, although he had taken the model of it because it struck him as being so extraordinary. He could not find out exactly what had happened, but he had brought it to show how teeth would travel. In the upper the molars were up against the canines. She was quite a good-looking girl, and no layman would have known she had had any teeth out. He thought it would be interesting to let them see what had taken place and how spaces would fill up in the most wonderful way.

Fig. 25.—The girl was $12\frac{3}{4}$ years of age. Nine years previously he extracted the lower incisor and two upper fives. He had got the case very nice when the girl went to live elsewhere. A few weeks ago she came back again, and a model taken of her mandible showed that the lower incisors were even more irregular than they were when he had taken out the incisor years ago. Evidently the same force which caused the crowding in the first instance had persisted.

Fig. 26.—A patient of his had come to him after she had had a regulation done by expansion. She had now worn a retention plate for 30 years to retain a refractory incisor, and he had that day made a new one and put it in. She was 46 years of age, and had worn a retention plate, chiefly at night, solidly all through that time—was it not pathetic ? A little extraction at the proper age would have made it unnecessary.

Fig. 27.—They now came to the vexed question of the extraction of the six-year molar, a proceeding which has been " utterly condemned " by Hubert Visick and others. This was one of the first cases he had undertaken. He had extracted the decayed six-year molars 33 years ago and brought back the anterior teeth. The model shown was taken not very long ago.

Fig. 28.—In this case the six-year molars had been extracted by Quinby, of Liverpool over 30 years ago. It was perhaps not as good an articulation as the one he had just shown, but it was not a bad one. It had served its owner well, and the mouth was clean and healthy.

Fig. 29.—Another case—the first molars were extracted before the second molar erupted, and there was a very good bite. That was at least 25 years ago.

Fig. 30.—Another case of the six-year molar. The girl was 18 years old. Her parents had neglected her teeth, and she came to him and wanted to know if he could do anything. The teeth, as they could see, were horribly overcrowded. On one side he extracted one, as well as a premolar on either side, and brought the teeth back. She had promised to come in on Friday, but had been down with influenza, otherwise he would have brought a model as at the present day. A very fair result, especially as regards appearance.

FIGS. 31 and 32.—A case of Dr. Angle's in which the canines were very prominent. The teeth had been reduced to regularity (Fig. 32), but he maintained that there was too much " tooth " about it altogether, and that if extraction had been performed it would have made those teeth less in evidence and more in harmony with the face. Making teeth regular was only a part of their job ; they had to produce a harmonious cast of features to get the best results. In a case like that, he considered it was a failure.

FIG. 33.—Upper models of above case. They show how teeth can be moved, but were they going to have permanency with all the teeth splayed out like that ? He considered they would not.

FIG. 34.—Another case of Dr. Angle's. Here was evidently an underhung jaw. If he had extracted and brought lower teeth back he would have made a better job of it.

FIG. 35.—Another case of Angle's. In which both the upper and the lower jaw were too prominent. He considered that if extraction had taken place and both upper and lower jaw had been brought back they would have obtained a much more pleasing result.

I wish to express my thanks to Mr. W. P. Lovelace, of the Dental Manufacturing Co., Ltd., for the excellent photographs and lantern slides.

beauty and to masticate food efficiently is all that the orthodontist need attain. I acknowledge that many cases can be treated without extraction and without disturbance of the articulation. With these I am not concerned to-night.

In my opinion, the practitioner, unfettered by any inflexible dogma, should be free to choose any method by which he may obtain facial beauty and functional efficiency by the most rapid and hygienic method at his disposal.

When I read my paper in 1914 I was a voice crying in the wilderness, although I must not forget that Frank Colyer had already published a book on the regulation of teeth, in which judicious extraction was advocated. To-day other voices are also raised in protest, notably that of Mr. Steadman in a paper read before this Society last December, entitled "Orthodontics for the Masses," with most of which I heartily agree, especially with that part of it in which he said: "I wish to make it clear that in some of these cases extraction is in my opinion the best treatment apart from economy." With him, I do not accept the proposition that the proper method is by non-extraction and that treatment by extraction is only a convenient second best. We consider that in many cases treatment by extraction with or without a subsequent appliance, is the proper method.

Mr. Steadman's paper, written for a special purpose, does not mention subsequent treatment by an appliance, but I am sure he agrees with me that in a certain proportion of cases an appliance must be worn to obtain satisfactory results.

The charges I bring against the American system are that it is often long and tedious, often injurious to the teeth and mouth, often ineffective and often expensive.

(1) In non-extraction appliances require to be worn in many cases for a number of years and the visits to the dentist have to be frequent.

(2) I have seen many cases in which the prolonged wearing of fixed appliances has resulted in the destruction of the enamel, producing permanent disfiguring of the teeth. To what extent this is caused by faulty technique I am not prepared to say, but that it frequently occurs is beyond question.

(3) Injury to the gums is no less certain. This can be caused by either fixed or removable appliances and, in my opinion, if regulation can be attained without any apparatus whatever (and by extraction this can frequently be done) it is the best thing for the patient. If an appliance has to be worn a removable one does less harm than a fixed one, and where extraction has been resorted to, the apparatus is worn for a much shorter period both for regulation and retention.

In this connection I will quote Dr. Stanley Colyer, the radiologist, who, in his recently published book on "Chronic Infection of the Jaws," says: "I am much impressed by the damage that the forcible regulation of the teeth of children may bring about in their jaws. Sir Frank Colyer has taught this for many years, and radiology most certainly fully confirms his views. In one case only which I can call to mind there was no demonstrable change; in all others there was clear radiographic evidence of varying degrees of damage. In the worst form there is absorption

of the apices of some or all the teeth regulated, together with a general infection of the supporting tissues. In less severe cases the infection is more localised, and sometimes partly cured, whilst in others it is possible that the repaired tissues may not have been infected. Some of the ill-effects of regulation appear to be due to the gingivitis set up by the regulating apparatus, whether this be of the 'fixed' or 'removable' variety. There are persons who take a light view of this gingivitis, considering it a temporary thing that can easily be dealt with when the other treatment of the case is complete. It is more than probable that this view is wrong, and that the gingivitis leads to an infection of the deeper tissues from which the patient may never recover. More damage however is probably done by the actual movement of the root of the tooth through the bony tissues, whereby their resistance is lowered and the way opened up for their infection. Further, it must not be forgotten that many of the children who undergo such treatment are often of a feeble constitution, some are the subjects of old rickets, others of tonsils and adenoids, whilst many—and this is most important—are affected with a marginal gingivitis even before the commencement of treatment. I am quite certain of my evidence when I say that the forcible regulation of children's teeth may lead to most disastrous consequences, and from a radiologist's point of view I unhesitatingly condemn the method."

(4) The expansion method is often ineffective, and few of us have escaped seeing cases in which the teeth have more or less reverted to their old positions even when retention apparatus has been worn for a long time. The reason is that the teeth have not been reduced to a state of permanent equilibrium. This equilibrium has a much better chance of being established when, by extraction, sufficient room for the teeth has been procured.

(5) The question of expense is sometimes a very important one. It has been gone into with considerable detail by Mr. Steadman in the paper referred to, and I do not propose to discuss it. I will only say that the labourer is worthy of his hire, and if we are honestly convinced that extraction is wrong we must solve the difficulty, if it arises, as best we may. If, however, we feel that extraction is right, we have the gratification of carrying out our treatment in our own way to the benefit of the child at a moderate cost to the parents.

In conclusion, I will refer to some interesting statements made by Mr. A. C. Lockett, Secretary to the European Orthodontological Society, in a paper read before that Society in May, 1925. That Society is, I believe, chiefly composed of American practitioners, and Mr. Lockett himself has studied in America. The paper is entitled "A Comparative Study of three American Textbooks on Orthodontia by Angle, Dewey and McCoy, with special reference to Finality in Orthodontics." Mr. Lockett, who writes in a vigorous style, is by no means satisfied with the teaching of the American school. He is convinced that there is in their minds a great deal which ought to see the daylight, and which up to the present has been kept in painful secrecy. He asserts that an honest confession and statement of these secrets will do more for the practice of orthodontics than "an apparent atmosphere of continued bluff and make-believe." After some very severe strictures on the writings

of his three authors, Mr. Lockett comes to certain conclusions " in the light of British experience and conditions," which seem to show that the permanence of treated cases claimed by many American authors is not as common as one would expect to find, in fact is a " gigantic gamble;" that treatment by expansion is often unsatisfactory to the parents from an æsthetic point of view; that school conditions in England are totally different from those in America and the question of remuneration with modern conditions in England has to be faced. He suggests that a book should be compiled showing results obtaining in cases supposed to have been finished five, seven or ten years earlier, and prophesies if that book ever sees the light it will be " an eye opener."

I shall now show some slides of cases treated by the extraction method, and you can judge for yourselves whether, after a considerable period, the results are satisfactory or not.

The conclusions I have arrived at are :—

Prevent the necessity of regulation by impressing upon parents the importance of mastication and of nose breathing ; warn them of the signs of nasal obstruction and of the dangers connected with adenoids and the tonsils.

If the teeth are fairly regular and the features pleasing do not regulate on account of the occlusion not being quite normal.

When regulation can be accomplished by extraction only, do not use any appliance whatever.

If for any cause it is considered advisable to extract the first permanent molars one need not hesitate to do so before the second molars are erupted.

Use removable appliances and insist that they be worn and kept clean.

Discussion.

The Chairman said that the applause of the members showed their very deep appreciation of Mr. Rushton's paper.

Mr. Lockett said : " The attitude of American schools of thought in orthodontics, so far as I know, happens to be more or less an agreed theory that the normal occlusion of all the teeth should be the ideal standard which all orthodontists should strive for. I was trained in that school of thought ; as an ideal I took no objection to it provided I was satisfied that the application of the ideal in practice gave universal results of a permanently satisfactory nature in adult life. I am satisfied that the past quarter of a century has proved that this ideal is capable of practical application in certain types of cases treated under favourable conditions, and that in others it is not. I believe that in a very large majority of cases of all types it is possible to put thirty-two teeth in normal occlusion simply as a feat of skill, and that some cases will remain in normal occlusion for many years, and that others will be in normal occlusion for a short time only. My feeling on this subject of ideals as against results is that it is the duty of an orthodontist to his patient to put the ideal into practice where he is satisfied that in doing so the best interests of the patient can be served thereby, and to depart from that ideal if convinced that the best interests of the patient will not and cannot be served by the application of an ideal principle. It is to a large extent a matter of individual responsibility of a man to his patients. I feel that Mr. Rushton's honest intentions will become something in the form of a reality when he has satisfactorily proved to the profession that extraction for a large number of cases is in the best interests of orthodontia study and practice ; but that will take some doing. My comment on the paper is that there is a tendency on the part of the essayist

to be extreme and to err in that respect, in just the same way as the idealist is extreme in his belief that anyone who disbelieves or departs from the ideal is wrong. The day is coming, and we shall see abundant evidence of proof in the next six years, when a reasonable compromise will be the generally accepted principle on which orthodontics will be practised and on which it will prosper, and be the guiding principle which will give the patient a fair chance of permanent and lasting results in adult life. It will be possible, I hope, under this principle to bring the benefit of orthodontic treatment to the children of 10 per cent. of the population of these islands, and all my efforts in the past four years in writing or speaking have pointed to this fond hope. I should be very proud to think that any of my efforts in this direction would be of some help to the movement 'Orthodontics for the Masses.' It is a great movement and worthy of support and sympathy, but it is so vast that I ran away from it and was satisfied with a 10 per cent. portion of the population as my portion of consideration." Speaking in a general way of the models that had been shown them that night, there was no question that the results had been brought about through extraction, and they enabled Mr. Rushton to present photographs of his patients which looked satisfactory in some respects. He thought, however, that the question of extraction of teeth in connection with the treatment of cases was a matter for very serious consideration before entering upon it. Speaking from his own experience, and after discussing it with one or two other men who had adopted somewhat the same attitude in America, his opinion was that they might find later, as years went by, that perhaps now they might be extracting (even in such cases as Mr. Rushton had presented) the wrong teeth, and they might have got better results by extracting others. He was speaking in a general way only. He agreed with everything Mr. Visick had said in a paper on cases of extraction of first molars. All those evils that he had mentioned could occur sooner or later—perhaps not in the same mouth, but in different mouths. If the first molar had to be removed at any time for any cause, or if anybody wanted to remove it for orthodontic treatment, if it was done just a year or six months before the eruption of the second molar, the second molar would go forward in a vertical position, and retain that position, such as the slide had shown. He thought they ought to get better results than had been shown, although some of the cases were not bad. He thought that half of them were fair; in the others the positions of the teeth might have been improved. The articulation might have been improved if there had been a little bit more exercise of mechanical thought put into the case. He believed that there were cases on record where it might be possible to bring about results by extraction in simple cases without treatment, but he deprecated the idea that they were going to treat cases by extraction only as a fixed rule, but he had not sufficient experience on that line to say much.

Mr. JAMESON asked Mr. Rushton if he would tell them what sort of plates he used for the regulation of those cases; his experience was that all plates were more often in the children's pockets than in their mouths.

The CHAIRMAN (Mr. Cale-Mathews) said that it was a mistake to think he was opposed to extraction at any price. He had only returned from Portsmouth that day, and in the morning one or two men, in considering a very marked case in which treatment by extraction was obvious if ever he had seen one, turned to him with the greatest surprise and said, "Fancy you advising extraction." When he was a student the extraction of the permanent molars was the orthodox routine treatment, whether there was overcrowding or not! There was a little word that crept in occasionally in Mr. Rushton's paper that was almost negligible but which, on careful reading, he thought would very largely qualify a great many of his apparently wide statements. He would ask those who would be reading the paper when

it was published just to look for those little words. He had noticed them and they were qualifications to broad statements—not one of them could help putting in those little words, perhaps for their own protection in the future, when they were writing or reading a paper. He did not accuse Mr. Rushton of side-tracking or wishing to save himself from any criticism in the future, because he had the courage of his convictions—he knew what his opinions were. With regard to the photographs, he had noticed that the first was frequently an amateur one, whereas the second was a professionally retouched one. That was one of the great difficulties they had, unless they had their own cameras in their surgeries, of getting true photographs of cases both before and after treatment. He would ask Mr. Rushton frankly whether there was not in every one of those photographs of the adult or child after a long period a marked contraction of the nose, a strained look about the lips, when extraction had been resorted to. There was another thing—extraction of two teeth in either jaw might mean that they had more movement of the remaining teeth than the placing of the teeth in the proper position without extraction implied. That was a point which he did not think was often borne in mind by people who would not wear an appliance under any circumstances. It was an appallingly large subject, and he thought that Mr. Lockett had placed the matter fairly straightforwardly when he said that idealism was the thing to teach, practise it where they could, and that they must take the best out of both methods. For his own part, when it came to a case of partial treatment by extraction, it afforded him considerably more anxiety than the most complicated treatment by mechanical appliances. Take, for instance, the case where the lower incisor was extracted and the ultimate crowding was greater than before that tooth was removed. He personally thanked Mr. Rushton for what he had said that evening.

Mr. Maxwell Stephens said a paper of that description was apt to make a little confusion in the minds of those who were starting practice. It should not, however, prevent their taking up a consideration of the subject from as wide an angle as they possibly could. They should not allow that paper to let them get lazy, without having thought of the possibilities of other treatment. They should consider adequately everything from the papers that were read there on different methods employed by various practitioners.

Mr. G. Northcroft said he had always held that they must treat every case on its own merits. They could not dogmatise about the treatment of any class of case, but they must work according to their patient's features and circumstances. By the latter he meant their school attendances, their parentage, hereditary factors, and a thousand and one things that occurred in considering the lines of treatment they had to adopt for each individual case. He very heartily endorsed what Mr. Maxwell Stephens said, that they should not, when listening to any papers delivered in that room, run away with the idea that what they heard was by any means final or the only word that could be said on the matter.

Mr. Bertram Samuel said that one of his first professional acquisitions after the war was the volume of *Transactions* of the 1914 International Dental Congress. It was the reading of the section on orthodontics that first really interested him in the subject. Mr. Rushton might recall the evening when they discussed his paper, which was one of the most interesting items in that section. He thought they should remember that a great deal of water had flowed under London Bridge (or Brooklyn Bridge, for that matter) since 1914. Mr. Rushton's original paper made reference to the American school, by which he understood those practitioners who affirmed that extraction had no place in the rational treatment of orthodontic conditions. He had read a mass of orthodontic literature, emanating both from America and this side, and he thought it would be generally conceded that

such a standpoint was no longer taken, and that the majority of serious practitioners in both countries did practise common sense, and that the policy of extraction had its place in all their minds nowadays. There was one other point to which Mr. Rushton referred. He mentioned a paper written by Mr. Norman Bennett, in which Mr. Bennett spoke of the English facial characteristics, in that there was rather a tendency towards a certain type. Many of the cases illustrated and criticised by Mr. Rushton were types that were given to the public by Dr. Angle in his book some thirty years ago, and of course he supposed they could not consider those to be British or English types. He would like to thank Mr. Rushton for his paper.

Mr. PITTS was in sympathy with a great deal that Mr. Rushton had said. He thought it was a very timely, courageous and common-sense paper ; it seemed to him that " extraction versus some other method " was a great fallacy. They should use whatever appliance might be best suited for the purpose, even if it happened to be a pair of forceps, and frequently the best results were to be obtained by a combination of both. There he was in sympathy with Mr. Rushton, for he found that in an earlier paper by Mr. Steadman too much reliance had been placed upon forceps alone, and he thought then that some of the results were poor. He thought that extraction plus other treatment admirable in a very large number of cases. He saw a case not very long ago of a girl with a very marked degree of superior protrusion. The first premolars were extracted and the case left, but a year later the second premolars had moved up in contact with the canines. The extraction had been absolutely wasted and some further extraction was going to be needed in order to remedy the case. There was the result of an attempt to treat the case simply as one of extraction. He noticed that Mr. Rushton described several cases of post-normal occlusion, where he had carried out extraction in the upper jaw, without any treatment of the mandible. According to the photographs, the chins appeared to be quite well formed as far as one could see. But in so many cases of post-normal occlusion the lower jaw was very undeveloped. What did Mr. Rushton do in those cases ? It did not seem to him that one was going to get the best result from treating the upper jaw only, if one left that under-developed lower jaw where it was. His own practice was to make the facial profile the deciding factor. If the chin appeared to be reasonably good, he ignored the post-normal occlusion. He considered that it was a good working occlusion which enabled a child to masticate any kind of food perfectly well, but if the lower jaw was badly developed, then it seemed to him that something ought to be done. He would like to know from Mr. Rushton what he did in that case. He had always felt any case of post-normal occlusion which called for extraction of lower premolars must be excessively rare. With regard to what Mr. Rushton said about first permanent molars he did not feel a great deal of sympathy. What was badly needed was the record of some hundred cases of extraction of first permanent molars, with models taken in later life and adequate history of exactly when extraction took place and the relationship to the eruption of the second molar. Then they would be in a position to know what results followed and the factors deciding them. He could not think that all the bad cases he had seen had been due to extraction of the first permanent molar having been done after the eruption of the second molar. He took it that nobody present had any sympathy with the view, which was prevalent when he was a student, that extraction of these teeth was a valuable treatment for malocclusion. As Mr. Cale-Matthews had said, extraction of the first molar was the routine treatment quite irrespective of its condition. He would like to thank Mr. Rushton for his admirable paper.

Mr. RUSHTON, in reply, observed that he had expected to be cursed like the gentleman in Scripture, but they seemed to have blessed him altogether, or very nearly so ! He had simply shown them what he

had done in certain cases in his own practice, and they must draw their own conclusions. He used removable plates in nearly all cases. He quite agreed with Mr. Northcroft that the ideal was (as he had said in the beginning of his paper) to take each case on its own individual merits. He did not go perhaps so deeply into the various factors in connection with a case as Mr. Northcroft did sometimes, as regards previous health, heredity, disposition, etc. Undoubtedly they were all very valuable in their way, but he took a case as he found it, and carried it through to the best of his ability, in what he considered the best interests of the patient. That was as far as he could go, and from the remarks that had fallen from the gentlemen who had been kind enough to discuss the paper, they were all very much in harmony on that point. Using the word "harmony," he agreed again with Mr. Northcroft that harmony was the thing they must strive to obtain by the best means in their power. As regards the photos, some were amateur, some professional; he did not ask for them to be professional, but as a rule when the mother saw her child restored to beauty once more she was only too delighted to present him with a professional photo, and it was a very nice thing to keep. He advised them all, when they had cases, to take, or have taken, photos before and after. Apart from any professional prestige, it was a very pleasant thing to feel that you were an artist creating beauty, and that your artistic work was appreciated. As regards the six-year molar, the thing was that if it were extracted it should be done at the right time, not as a routine practice as old practitioners did. Mr. Pitts had asked what he would do in extreme cases of receding chin. Honestly, he had had no cases; at least, he could only remember one, and he had left it alone; he wished somebody else to take it on. He felt he could not do anything worth doing without destroying the harmony of the rest of the features. It seemed to him that it was one of the most difficult things in orthodontics to make a chin when there was not one. He would like a paper read on that point by those people who had done it. He thanked those present very much for the patience with which they had listened to him, though they might not all agree with him. As orthodontists they had a great many opportunities of being very useful and helpful to their fellow-citizens. He thanked them very much indeed.

MY WORK AND EXPERIENCES AT THE POST-GRADUATE SCHOOL OF ORTHODONTIA, UNIVERSITY OF PENNSYLVANIA.*

By Norman Gray, L.D.S.

In presenting my paper to you this evening I must thank you for the honour you have done me by asking such a recently elected member of the Society to speak to you. I trust I shall be able to bring to your notice something of interest from the other side.

There are two avenues of approach. One would be to describe as fully as possible the various techniques employed in treatment; the other, the basic principles underlying the treatment. I have a few slides showing technique, but as time is limited to-night I propose dealing with basic principles as I have been taught to understand them. I do not propose to tell you of the side which we all know. I shall try and give you an idea of the teaching which differs from this country, and I will deal more with diagnosis than treatment.

* *Transactions*, Nov. 1st, 1926.

Please do not expect to hear details concerning half-round tubes, molar bands, lingual and labial arches, auxiliary springs, etc. You will see that *ad lib.* when you attend the Congress in New York and Philadelphia this summer. But what you may not be prepared for is the new attitude towards diagnosis. The whole aim of many leading American orthodontists is to get away from a picture of tooth relationships, and to see instead a picture of general development.

In the evolution of the professions, the activity of our own profession of dentistry is looming large on the horizon of human welfare. The importance of our function is daily becoming more manifest. To us is given to guard the very portal of human life. The first few inches of the alimentary tract, which conveys to the body the nourishment so necessary to its existence, are committed to our care. Incidentally, it is the only part of the entire tract over which humanity has been given the least control. To keep the mouth and teeth in a condition of full functional activity is to go a long way towards keeping the whole body healthy and efficient.

In a general way, dentistry resolves itself into three main divisions—dental pathology, dental prosthesis, dental orthopædics. We know that the future of the nation is the child, and I think we all feel that orthodontia is drawing nearer to that ideal labelled "Preventative Medicine," and thereby has done, and is doing, more to elevate dentistry than any other branch of our work.

The idealism in mechanics that marked the early days of modern orthodontic practice in the United States has developed a technique that is unsurpassed throughout the world. It was to gain a better knowledge of these methods and to cultivate a mechanical dexterity that I crossed the Atlantic. I certainly feel that I have benefited in that direction, but I have learnt to my surprise that the direction of future progress is through the study of biologic principles that concern function, nutrition, metabolism, the repair of the tissues, and the thoughtful application of such principles to every phase of the art of dentistry.

I want at the start to make it very clear that these remarks are not my own findings, but the opinions taught by many of the leading orthodontists over there. The University of Pennsylvania is one of the first dental schools to branch out into something new even for America—a graduate course in orthodontia. The course occupies one full academic year, beginning on October 1st. Graduates from the accredited dental schools of all countries are accepted, provided they undertake to complete the full course.

You know that for many years orthodontia has been practised as a speciality in the States. Gradually the feeling has arisen that this field has become too big to teach to students taking their degree. At Pennsylvania the teaching of orthodontia to undergraduates consists of lectures on basic principles, the construction of molar bands, lingual and labial arches, and plaster impression-taking, together with demonstrations and quizzes given by the graduate students. They do not treat patients. Whether this is a good policy or not has yet to be proved, but holding the quizzes and giving the demonstrations to others has been a very valuable experience for me. The course began with a series of informal talks,

in which the general principles of orthodontia were discussed, and questions were asked in order to find out the extent of our knowledge. There were eight of us taking this special work. We very quickly became acquainted because our first piece of technical work was to take two sets of plaster impressions of one another, which I commend to you all as a most intimate form of introduction, besides being a very illuminating experience. We poured and carved the first two sets of models ourselves for experience, but after that all the impressions were sent to a laboratory. Next followed a week of continuous free-hand soldering and technique work. We had a few hours' intermission in order to attend special lectures on Child Psychology, and a Defective Speech Clinic. Our syllabus was arranged so that we could watch surgical operations such as cleft palates, resection of the jaws (and similar cases in which the orthodontic department was co-operating). Opportunity was also given to hear Dr. Prinz on Diseases of the Mouth and Oral Hygiene, besides lectures at the University in Pediatrics, whilst later came courses on diseases of ear, nose and throat. These additional subjects were continued throughout the year and were very valuable and much appreciated.

In our lectures with Dr. Leroy Johnson, it soon became evident that we were to approach orthodontic problems from a very different angle than heretofore. Dr. Johnson is a man who believes that no opinion, beliefs, nor convictions, even though advanced by men otherwise highly deserving, can take the place of real and sufficient evidence. His lectures covered such subjects as Terminology and Definitions (dental terminology is strangely limited)—The Morphology of Teeth—The Law of Variation—What is Normal?—The Law of Occlusion—Type and Form—Evolutionary Tendencies—Habits—Heredity—Harmonious Development and Growth—Dietetics—Physiology of the Oral Tissues—Problems of Bone Formation. A paper could easily be given by anyone. I can assure you they all have a very definite bearing on our work and will well repay their study.

Dr. Thomas W. Evans (the Court dentist of Louis Napoleon) founded the Dental School of the University. He stipulated in his will that a considerable sum of his money be devoted to dental research, with the result that they have a very nicely equipped research department. Every facility was offered to induce each one of us to make a study of one of the biological problems of modern orthodontia. Dr. Rittershofer of Michigan, for example, is checking Oppenheim's orthodontic experiments on the jaws of apes, and I think his paper at the New York Orthodontic Congress in July will contain some interesting and valuable results about the physiology of the alveolar process in relation to growth. Other subjects being investigated are: the heredity factor in dentition as indicated in the study of identical twins; relations of muscular activity to the osseous development, with special reference to facial structures; the metabolism of cementum during tooth movement; a study of the condylar paths in relation to functional occlusion of the teeth.

I suppose you would like me to refer briefly to some of the points raised in the lectures. You will find it elementary, I fear. When we study malocclusion of the teeth and maxillary and mandibular

deformities in the light of biology, orthodontia is to us then the branch of dental science which treats of the development and correction of malocclusion of the teeth. Thus it has to deal with the laws which underlie the growth and development of the dental apparatus as a whole. So long as strictly mechanical conceptions of orthodontia are in vogue, the rest of the profession will give it little attention, and so will the medical profession and incidentally the general public. Diagnosis of deformity involves something more than the recognition of an irregular alignment of teeth : and treatment, instead of being merely a question of mechanism of tooth movement, is an attempt to influence developmental processes and perverted functional activity. Tooth movement is simple ; the treatment of maxillary deformities complex.

We believe that orthodontia is a well-defined branch of biology, so it must conform to the conventional principles of science in general. By this we mean it must be founded upon a general truth, or the operation of a general law and the facts relating to this law must be systematised as they are revealed, in order that they may take their place in logical sequence as the science grows.

Hypothetical Occlusion.

In the study of occlusion we need a working hypothesis. In any investigation it is necessary to begin by assuming certain things to be true. They may or may not prove to be true as a whole, but as a theory which serves as a basis for study, it must be probable. It must have its foundation in reality.

Mechanical *v.* Biological Hypothesis.

At the meeting of the European Orthodontological Society in London last year, just before I left, there seemed to be a general feeling that a weakness had been discovered in the ideal arrangement of inclined planes of the cusps as the hypothetical basis for the study of occlusion. I believe this was brought about through the paper and reports of Dr. Hellman[1] of New York. Hellman flatly contradicted the idea of normal occlusion being a certain ideal relation of inclined planes of the cusps of teeth with the jaws closed. He very conclusively showed from actual observations that the occlusion of teeth in man is not a relation of inclined surfaces.

Dr. Leroy Johnson,[2] speaking to a conference of teachers of orthodontia, says : " In being more observant of facts Hellman's hypothesis links the phenomena of occlusion with the evolution of the denture as a whole. It is the basis of the biology of occlusion, As most of you know, the scheme he offers is as follows : first, contact of the labial surfaces of the lower incisors with the lingual surfaces of the upper incisors ; second, the point and fossa contact. as of the points of the lingual cusps of the upper premolars in the distal fossa of the lower premolars ; third, the ridge and embrasure contact, as the triangular ridges of the buccal cusps of the upper premolars between the lower premolars and the same with the lingual cusps of the lower premolars between those of the upper series ; fourth, ridge and groove contact, as is effected by the triangular ridge of the mesio-buccal cusps of the upper molars

into the buccal groove of the lower molars. From our knowledge of the evolution of tooth forms we find that the mesio-lingual cusp of the upper molars is the protocone of the original tritubercular forms and that the mesio-buccal cusp of the lower molars is the original protoconid. The manner of their interdigitation in occlusion shows these cusps to be of primary importance in maintaining the normal antero-posterior relations of the teeth. In fact the occlusal relation of the mesio-lingual cusp of the upper first molar in the central fossa of the lower first molar is the pivotal centre about which the evolution of the human denture in the molar and premolar region revolves.[3] The relations pointed out by Hellman are historical landmarks in the evolution of occlusion. They constitute the elements from which to build a rational scheme for the study of typical occlusion and are more expressive of actual conditions than the theoretical division of a cusp into four plane surfaces."

Typical Occlusion.

After our lectures had established the foregoing as a working hypothesis, we next had to face the problem of normal occlusion. The first step is to determine what is typical of the human race to-day in 1926. We must know what is typical before we can know what is normal. *The term type* refers to an abstraction determined by the extent and direction of the individual variations. Such is the definition given by Davenport in his book " Principles of Breeding."[4] Type is a model or pattern from which each individual varies in some degree. Our conception of type defines certain limits of variation. When we have ascertained conditions of occlusion that are typical of the human race, the next step is to determine the normal.

Normal Occlusion.

Type in occlusion is characterised by the well-defined relations mentioned earlier, i.e. surface contact of incisors, point and fossa contact of molars and premolars and so on. Individual variations show a wide range of differences within the limits of type. Our difficulty is to define these limits of type. If a survey of the occlusal conditions shows relations sufficiently uniform to mark them as within the limits of type, we may safely conclude that they are normal.

I believe in England we have been speaking of the hypothetical ideal occlusion as our basis of normality. The criticism of this in America is that if ideal is our standard of normal occlusion, surely every individual case must vary from the ideal in some particular and so be abnormal. In reality the standard should be type, so why not call it TYPICAL occlusion. As type recognises individual variation, the question then becomes to what extent can an individual vary from type and be in the range of normality ?

Hellman explains it like this : because Sandow represents the ideal in strength and physical development, it does not prove that all those not corresponding to such a criterion will be *abnormal.* It is the standard adhered to by the greatest number of individuals free from disease, weakness or deformity that decides the question of type or normality, and not the individual personifying an ideal

that may have been artificially developed by intensive and careful training.

Johnson's definition of normal occlusion of the teeth is the condition of tooth relations that is most effective in maintaining and establishing in its most stable form the organisation of the living being.

Malocclusion, its Classification and Diagnosis.

Dr. Angle[5] in his classification of malocclusion of the teeth states: "These classes are based on the mesio-distal relations of the teeth, dental arches and jaws which depend primarily upon the position mesio-distally assumed by the first permanent molars on their erupting and locking. Hence in diagnosing cases of malocclusion we must consider first the mesio-distal relations of the jaws and dental arches, as indicated by the relation of the lower first molars with the upper first molars—the keys to occlusion, and second, the positions of the individual teeth, carefully noting their relations to the line of occlusion."

Hellman[1] says of this: "In these two sentences there are implied several ideas, each of which may be considered as independent of the other. Thus we have first the foundations upon which the classification is based; secondly, diagnosis based upon the same principles as those underlying classification; thirdly, treatment, though not indicated, is implied for the entire scheme of the classification, and diagnosis is conceived of as an adjunct to the method advanced in the correction of malocclusion, and lastly, a terminology explaining classification and diagnosis."

Classification, according to the "New International Encyclopædia," is a statement of near or remote relationships, according to the degree of differentiation the forms sought to be classified have undergone.

Diagnosis, according to Black's "Medical Dictionary," is "the art of distinguishing one disease from another, and is essential to scientific and successful treatment." It is in diagnosis more than in treatment that the highest skill is required, and for a diagnosis the past and hereditary history of a case, the symptoms complained of, and the signs of the disease found, are all weighed. Often an absolute diagnosis cannot be made at once, and it becomes necessary to proceed tentatively with treatment, a careful watch being kept upon its results." This is worthy of particular notice as it is of the utmost importance in orthodontia.

Thus we see that Angle sorted out into certain characteristic groups the various types of malocclusion, but such a procedure does not necessarily imply diagnosis of the phenomenon. If that were so, as the Angle school imply, it would be a relatively simple matter to treat every case we meet by rule of thumb methods. In America, Angle's classification has been accepted in the nomenclature as indicative of tooth relations, but the Angle theory that the upper first molar is constant in its relation to the rest of the skull is no longer accepted as a basis of diagnosis.

Growth and Development.

Sixteen years ago Angle published an article in the *Dental Cosmos* for March, 1910, entitled "Bone Growing." In the article he says:

" Our successes in treatment depend upon our success in bone growing, and if the orthodontist does not succeed in growing bone, he will find in time that the teeth he has moved so dexterously and satisfactorily have all returned to very nearly their original positions." Later, speaking of the " working retainer," with this appliance " he believes the cells involved in these tissue changes will be gently stimulated to greater and longer activity with the more speedy and complete development of the tissues."

Whatever degree of latitude Dr. Angle meant to be used in interpretation of such statements, he has undoubtedly created a world-wide impression, nay conviction, that bone can be stimulated to new growth at will by means of appliances, and one must judge a doctrine by the results on its followers. There seems to be no doubt that the form of bone can be modified by physical force within certain physiological limits, but the phrase " bone growing " does not suggest these very definite limitations.

At Pennsylvania we were very interested in the controversy on bone formation, and all the proceedings of the English meetings are eagerly read. Wolff's conclusions, incorporated in his law of transformation of bones, doubtless influenced Angle: " Wheresoever stresses of pressure and tension are caused in a bone, be it by pressing forces or by pulling forces, formation of bone takes place." Wolff seems to be supported by Oppenheim's investigations and by Roux; on the other hand, Murk Jansen's argument is so convincing in his criticisms of Wolff's law that Americans pause before presenting it to the student as truth in the problems of bone formation. Angle's creed that " bone grows as a result of mechanical stimuli " is only accepted provisionally in America. Anyone who will study the phenomenon of growth will find our knowledge so limited as to give ample incentive to query some of these old ideas. In biology, development means " the differentiation of organs and functions for specific ends, without necessarily an increase in size."

Growth refers to increase in size through the multiplication of cells, but not involving adaptation for particular purposes. Growth must be regarded as the index of life. We test the vitality of micro-organisms by determining if they are capable of growth on a sterile culture medium. Growth cannot be supplied from extraneous sources in the slightest degree. An orthodontic appliance may excite it to activity, but the idea of making bone grow by means of any mechanical device is unreasonable. The germ grows by incorporating food, water and salts. Hence the significance of nutrition in the problems of growth. It undoubtedly takes precedence over mechanical stimuli or any other agency within our control. Thanks to the work of Mellanby, McCollum and Howe, the orthodontist will see in many cases a general lack of fitness is the cause of deformities rather than the mechanical effects of so-called tongue and lip habits. Bottle feeding was considered bad because of the lack of muscle exercise. Now we consider that factor nil compared with the quality of mother's milk in supplying developmental needs.

It is a matter of clinical experience that when the dental arch form, or arch relationship, is changed from a malformation in the direction of an improvement, in a proportion of cases there is a

marked tendency towards a return to the former condition, or to another condition which may not be the former relationship, but on the other hand is not the relationship that was the goal undertaken. We have come to see that the teeth retain their relationship and position in the arches, not by virtue of their being solidly placed in hard bone and therefore fixed, but by virtue of a balance of forces. Tooth position and form of arch represent the sum total of the metabolic forces acting on the teeth. Bone may be hard to the touch, but except in certain pathological conditions, it is very responsive to forces acting upon it—more so than muscle. We know that when a tooth is removed the space created actually begins to close. In other words, the teeth on either side begin to move. The bone gives way. We have not removed a unit in a stable relationship of parts, but we have disturbed a mobile equilibrium.

Conklin,[6] in " Heredity and Environment," says of living cells and organisms, that " they are not static structures that are fixed and stable in character, but they are systems that are undergoing continual change. They are like the river or the whirlpool or the flame which are never at two consecutive moments composed of the same particles, but which nevertheless maintain a constant general appearance ; in short, they are complex systems in dynamic equilibrium." Likewise, the forces holding the dental arch in position are never at rest, and the catalogue of these forces is not exhausted by enumerating the more obvious, as muscle pressure of tongue, lip and cheek, and the thousands of daily contacts of opposing teeth during mastication. We must go further and visualise the surrounding tissues in all their complexity and manifold functional activity, and we must think of the integrating influence of circulation, nerve and endocrine activity.

I am afraid you will say this is all elemental and purely theoretical, and not at all the practical expression of American orthodontics that you wished to hear. Perhaps the reason I have stressed it so much is because it was all so new to me. I confess that to me orthodontic diagnosis was entirely a question of tooth relationships. The teaching in Pennsylvania aims at impressing the idea of diagnosis of the underlying cause, but notice that they have not simplified our problems thereby.

Diagnosis in modern medicine has progressed considerably, but leading authorities[7] say there has not been a corresponding advance in treatment, because the chief factor in determining whether a person remains in health, or recovers it when lost, is his innate adaptive power. If he has this power the wise physician or orthodontist can greatly aid. If he lacks it, he stays ill and considerably frets the honest doctor. I feel this applies markedly to our orthodontic treatments. We can also aid the development of the dental structures by removing infection and other deleterious agents. We can aid by increasing its self-adaptive powers and developmental processes, and we can check oftentimes pernicious habits that would hinder or distort these processes. We can help *indirectly* by guiding internal and external conditions through proper feeding. We can alter the structure of the jaws and soft tissues by the removal and repair of worn-out parts, and by the use of mechanical appliances can clear away often insuperable

physical barriers, and that is just about all we can do, and it is all that physicians and surgeons ever profess to be able to do in general medicine. The more we know of growth the more we must stand in awe of it and realise we are practically powerless to direct its course. When we hinder developmental processes through our treatment I am reminded of an old saying that the mistakes of physicians are buried in the ground, the mistakes of lawyers are dangled in the air, but the mistakes of dentists stare them constantly in the face.

Diagnosis and treatment as a subject for investigation embraces a field that is very large, the interpretation of our findings is difficult, and the meaning of data collected is still obscure. At the school, in order to arrive at the physiologic age, we took the height and weight of each child. We also measured the vital respiratory capacity, and made the dynamometer muscle tests of tooth and lip pressure that have interested Mr. Sheldon Friel so much. As we noted the variations in pressure exerted by the different classes of malocclusion it began to interest us too. But this data is quite insufficient to give a clinical picture until some thousands of comparisons have been made.

I have been taught to be afraid of appliances and to use the absolute minimum. We shall *never* be able to get away from them altogether because of the very nature of our work, but I am convinced that the sooner we get away from cumbersome masses of material, heavy springs and screws, multiple bands and ligatures, thick vulcanite plates, the better for all concerned. We shall design our appliances to simulate the delicate pressure of natural developmental forces. We shall be on the look-out for bad habits to correct first, faulty breathing, tongue, lip and thumb sucking, diet, position during sleep. We shall talk more about health, oral hygiene, diet. We shall learn the limits imposed by general feebleness of growth, whether the disharmony can be corrected by building up bone and muscle to the requirements of the teeth, or whether tooth substance must be sacrificed for the good of the whole apparatus. We shall encourage muscle exercises. We shall be more concerned with function than an unattainable tooth relationship. Time forbids me outlining the different techniques—perhaps you will allow me another opportunity some day.

In closing, I ought to mention one of the most striking features about the course was the arrangement later in the year of a weekly visit from some orthodontist of note. Each brought something of peculiar interest. Dr. Oliver of Nashville, Tenn., was our first visitor. I fancy he is known to most of us here, as is Dr. Mershon of Philadelphia; the latter took us *en masse* to his club for dinner, and then round to his office later in the evening. He described his method of diagnosis and treatment very much on the lines of his talk here last August, and then gave a very interesting account of how he evolved the lingual arch, concluding with a practical demonstration of technique. We then had Dr. J. Lowe Young of New York, who gave a lantern lecture on the pin and tube appliance, a vastly different principle from either of the other two, but extremely interesting and full of practical hints. Next came Dr. Weinberger, also of New York. He spoke for nearly three hours on the history of orthodontics; he was a mine of information.

It was astonishing to note that we still persist in a mechanical point of view in spite of the light of past history.

We should have had a visit from Dr. Hatfield, but sickness prevented. Dr. Rogers of Boston gave a delightful account of muscle training exercises, and showed many models and photographs illustrating his results. Dr. Kelsey of Baltimore spoke on difficult cases in private practice. Dr. Hellman of New York spoke on biometrics, or how to interpret statistics.

This is my maiden speech ; I trust you will accept it with that in mind. I have been tremendously impressed with the enthusiasm of the American orthodontist in his work, particularly with those who work along the lines I have indicated, and with it all they have a cordial fraternal " get together " spirit, which is most invigorating and refreshing, and altogether irresistible. May we in England learn more and still more to walk along such celestial paths.

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Discussion.

Dr. Livingston said he felt called upon to take part in the discussion for the very good reason that he had lectured to Mr. Gray, and now Mr. Gray was lecturing to him. He wished to thank Mr. Gray for the substance of his paper, and to congratulate him on having the advantage of residing in America, and to welcome the news brought from that side of the Atlantic. Evidently Mr. Gray had considerably benefited by what he had learnt in America, and he had passed on that benefit to the Society. It seemed, if one might judge a little of America and what was going on there by what Mr. Gray had said, that they were still vague as to terminology ; they were still a little inclined to quarrel with the standard terminology, and a perusal of their journals led one to the conclusion that the terminologies were steadily drifting apart. There was another tendency on the part of their United States colleagues that had always been present ; they were rather apt, by the use of a large generalisation, to hedge on details, as instanced by the use of the word " biology." Dental surgeons this side of the Atlantic had studied biology, and if he was not mistaken, the very first University course that Mr. Gray ever attended was a course in biology. The slight differentiation in the matter of terminology was evidenced in the use of the words " ideal," " typical " and " normal." In the first place, the words " ideal," " typical " and " normal " in the English sense meant almost the same. Those words certainly stood for something which he wanted to explain. The members knew what it was ; he was not hedging himself ! To begin

with, the ideal or the typical or the normal did not exist. If one photographed all the male faces in that room, put the negatives one on top of the other, and then printed, one would not arrive at the normal, one would not arrive at the ideal, and he doubted if one would arrive at the typical. One would simply get a mass photograph of so many people, and not necessarily the ideal, the typical or the normal. He failed to see that Sandow could be regarded as an ideal; he was not—he was pathological! He did not want to say a word against Mr. Sandow—*De mortuis nil nisi bonum.* Sandow himself, he believed, was depressed occasionally; he had to get muscles down, not to get muscles up. Another point of terminology was that in the United States they used the word "diagnosis" where the Englishman would say "recognition." One did not need to diagnose every dental condition. If a patient came with a missing central incisor there was no need to diagnose that; it was recognised at once. Diagnosis in the proper sense was a splitting apart. One did not diagnose a condition; one diagnosed it from something else. For example, one would diagnose tuberculosis from actinomycosis. Some things were recognisable at sight. There was one question which intrigued him, whether in the case of certain words which, to us misspelt, the pronunciation was changing. For instance, spelling amide without the *e*—amid; and he would like to know whether they pronounced it accordingly.

Mr. GRAY said they pronounced it with a short *i*.

Dr. LIVINGSTON said that that was the danger. In the matter of variation, he had asked an eminent M.O.H., a statistician, if he knew certain facts about fevers—for instance, the variation of virulence. In reply the M.O.H. had stated that even with the statistics of 2,000,000 people to help, he knew nothing. The speaker would point out how little we knew yet about any variation. He would conclude by again thanking Mr. Gray for his interesting paper.

The PRESIDENT said he would like to ask Mr. Gray one question which to him seemed the all-important question arising out of his sojourn in the States. Very much of what he had told the meeting could be read. He would like to ask Mr. Gray what practical evolution there was, and if he had done any clinical work.

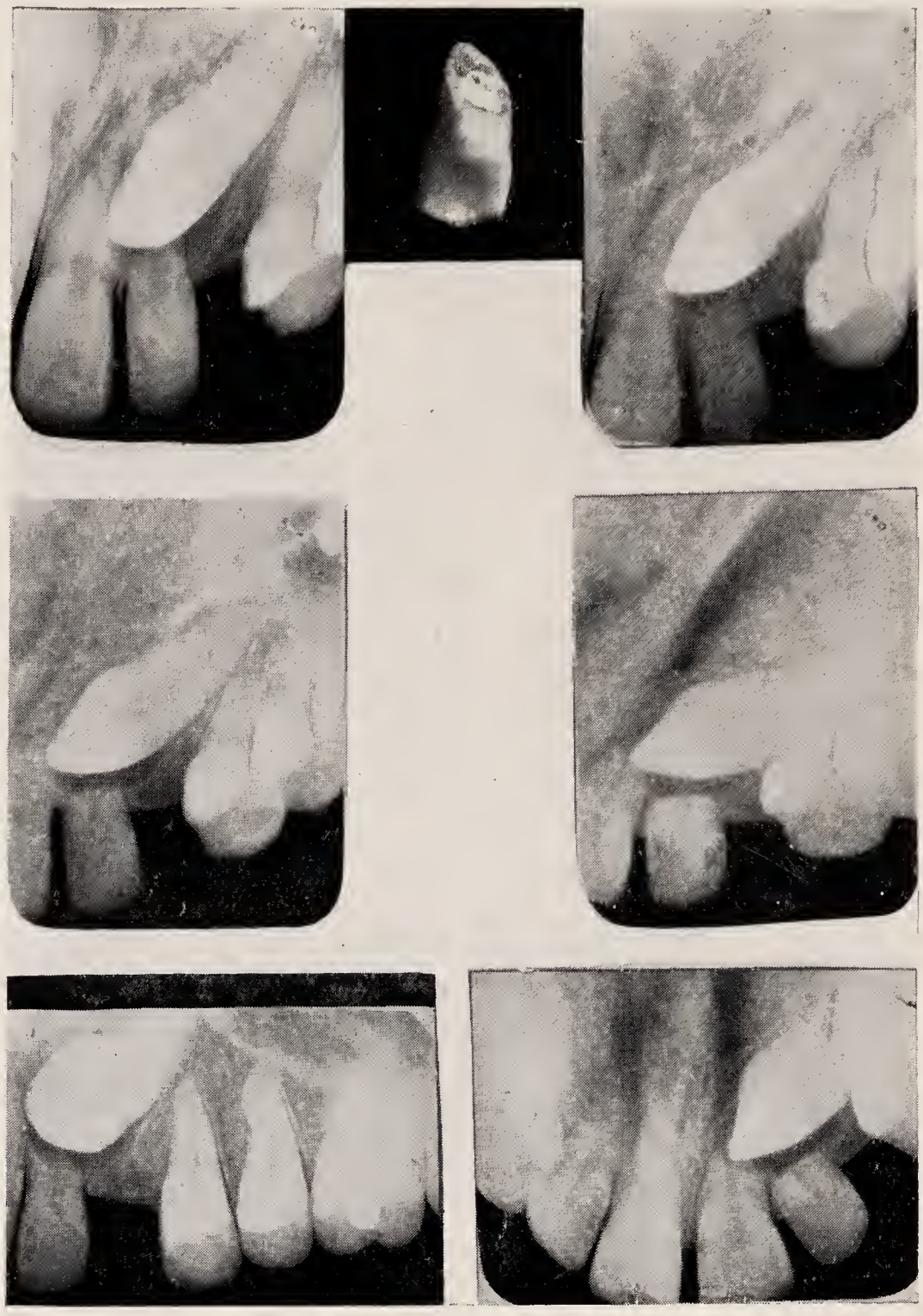
Mr. HAROLD CHAPMAN said he wished to add his word of congratulation to Mr. Gray on having had the opportunity of going to the Post-Graduate School of the University of Pennsylvania. The Society was fortunate in having a student from there to address it on his work and experience. As Dr. Livingston had pointed out, there were many questions of a highly controversial nature in the paper. He did not propose to enter on those, but he did notice that in summing up the branches of dentistry Mr. Gray had divided them into three, and instead of calling the third one orthodontia or orthodontics he called it dental orthopædics. That seemed to be a very important differentiation. He himself regarded orthodontics as dental orthopædics, or, as Mr. Northcroft called it, odonto-prosopic orthopædics. Unfortunately that name always brought forth laughter; nevertheless it did tell one really what the subject dealt with, and orthopædics alone was more explanatory of what they were doing than orthodontics, which referred to nothing more than teeth, whereas Mr. Gray later on made it clear that orthodontics was really dealing with bone, but he did not put it quite as plainly as he (the speaker) wanted to do. Mr. Gray quoted words to the effect that all they could do with the bone was to change its shape; he was inclined to think that that was very largely true. The question of being able to grow bone, it seemed to him, was very doubtful. He looked upon it more in the way, to take a simple example, of the straightening of bow legs. Those could be straightened quite easily. When he said easily he meant

to imply that it was a common operation that could be performed successfully, but abnormalities in the case of the jaws were not so easily dealt with. Owing to their small size and inconspicuousness the shapes of the jaws and their relations to one another when abnormal were not conspicuous until the permanent teeth erupted and caused a magnification of the effects, as it were, of malformed bones. It seemed to him that orthodontics was really a matter of changing the shape and perhaps slightly increasing the size of the maxillary bones as those bone shapes and sizes were expressed by the teeth, and in so doing the positions and relations of the teeth to one another were changed. It seemed to him that if members could get that main principle from Mr. Gray's paper they would have learnt a very valuable lesson, quite apart from the controversial problems as regards terminology. There was much more he would have liked to say, but as there was another paper to be read he would conclude by again thanking Mr. Gray very much for reading his paper so soon after his return from America.

Mr. Maxwell Stephens said that Mr. Gray would have them believe that he had gained his enthusiasm only as a result of visiting America ; he thought it was obvious, however, that he must have had much of it originally to take him there, so he did not think that we could be altogether on the debit side here.

Mr. Norman Gray, in reply, said he must apologise for the way he had read his paper. As he had said before, it was his first experience of reading some fifteen or sixteen pages without a stop. He thought Dr. Livingston had probably misunderstood him in one or two respects. The remark about Sandow really was to show that such development was pathological ; it certainly was not typical of the race. With regard to nomenclature, in some details the Americans did undoubtedly differ from ourselves. He was thoroughly English and did not intend to absorb their phraseology. He only went over there to see and learn something of the mechanical ability they possessed, and was surprised to find the importance of the biological point of view. Speaking about normal and typical, it might be that they had a different value from that prevailing in England, but at the same time he thought there was very much in common. They were really trying to say, "We cannot call any specific dentition absolutely normal," whereas the term "type" infers a variety of cases. He had not quite explained what he wanted to explain even then. If one could illustrate with a circle, dotted about inside the circle were the limits of type. Outside one got the atypical. The difficulty was to limit the boundary of type. With regard to Dr. Livingston's point about "diagnosis" and "recognition," he thought the word "recognise" would be better. They wanted to recognise the underlying causes of the trouble. Everyone wanted to do that ; but if one could recognise the underlying cause as a general feebleness of growth, then the treatment would be different. The more one learnt about growth, the more one was inclined to treat it with respect. He did not vouch for American pronunciation at all ; he could not help picking up some of their expressions, because he had been listening to them for so many months —the difficulty was to get back to normal ! Next time he would try and speak the King's English. With regard to Mr. Cale-Matthews' question about the practical side of the work, the lectures were given twice a week, and he was given a list of some forty books to read ; if one absorbed knowledge at that rate one was apt to get a little involved. He had had, as a matter of fact, quite twenty cases of his own, which meant a great deal of practical work. They had started within two weeks, and the greater part of the work was practical work, but at the same time, in using appliances one must apply one's knowledge to what one was doing, and that was why he had stressed

CASE OF ABNORMAL ABSORPTION OF PERMANENT ROOT.*



Mr. W. A. Crane described the case of a uniformly under-sized female child with clean healthy mouth and good arches, free from caries. History of delayed dentitions. At age 14 dentition complete except right upper deciduous canine still in place but showing signs of shedding. This was extracted. At age 15 very slight loosening of the permanent lateral which responded to thermal tests. Canine still absent caused X-ray photo to be taken. Much absorption of the permanent lateral root by pressure from the fully formed but unerupted permanent canine. Lateral extracted immediately. Treatment suggested : period of six months and further X-ray. If no improvement in position of the canine attempt to draw down the canine by the assistance of lingual arch and auxiliary spring.

* *Transactions* of British Society for the Study of Orthodontics.

what had been called a biological point of view. He agreed with Mr. Chapman about changing the shape of bone. He thought that was what the Americans were trying to bring about. The controversy was whether the growth of *new* bone could be stimulated. They could, of course, change the positions of the teeth within bone.

Discussion of Mr. Crane's Communication.

Mr. G. Northcroft said that while he was in New York a questionnaire was passed round in order to ascertain from those who attended that meeting whether they approved the principle of invariably taking X-ray photographs for orthodontic cases. The case quoted by Mr. Crane seemed rather to point to the fact that it was advisable, as a routine method in all cases which might require orthodontic treatment, to have the X-rays taken first. It might avoid a complication of the kind mentioned. If one could have seen the exact position first it might have been possible to have done something.

Mr. H. Chapman said that he had a case at the present time which showed absorption of the lateral's root, though not to the extent that appeared in the case just cited, but it was sufficient to say that he thought the tooth would be lost within a few months. In his case the canine was not lying horizontally or semi-horizontally as had been shown—it was perfectly vertical, but had erupted exactly over the lateral, so high up that it had to be exposed under an anæsthetic and a band put in so that it could be pulled down. It seemed to him that when the crown of one tooth came almost into contact with the root of another, the root was particularly liable to be absorbed. Mr. Northcroft's remarks reminded him of a paper that had been read in New York in which it was pointed out that absorption of roots occurred in cases where there had been no orthodontic treatment as well as in cases where there had been orthodontic treatment. In the case he was referring to there had been treatment, but he did not think there was any doubt that absorption took place before any treatment.

Mr. C. Schelling said that in advance of every erupting tooth there was a very great absorbent force, which no dental or bone tissue could resist. He had seen many similar instances to the case exhibited.

Mr. Crane, in returning the proof sent to him for perusal, wrote:—"The only addition I would suggest is that you might stress the abnormal amount of absorption in a child of this age as distinct from what is fairly common in older individuals. Had I been at the meeting I think with regard to Mr. Northcroft's remarks I should have pointed out the necessity for a series of photographs, as the first one while good does not give any indication of the real state of affairs."

Report of Curator for 1925-1926.

During the past year gifts for the museum have been received from Messrs. Bryan, Cale-Matthews, Chapman, Cotterell, K. Grayson, James, Northcroft, Ovey, Paul, Payne, Riddett, Rushton, Bocquet Bull and Miss K. Smythe.

We have to thank Mr. Badcock for allowing the use of a room in his house in which to collect the specimens. For their permanent accommodation the cabinets presented to the Society by Mr. Lewin Payne and Mr. Harold Chapman are ample; they will house all the

specimens obtainable for some years to come, and owing to the design will keep them dust-free and in perfect condition. I hope that those who have records of sequential cases which they value will remember this.

The greater number of casts presented are of academic value only, of great interest but not a direct aid in the teaching of orthodontics. It is these sequential models of treated cases of malocclusion for which I appeal and particularly for examples in the deciduous dentition which foreshadow the malocclusions of the permanent.

I congratulate you in electing Mr. Fouraker to the office of curator.

I feel that in not having completed the mounting and arrangement of the larger number of specimens which have accrued to the museum this year I owe him assistance. In the first report he presents to you he will be able to lay on the table a completed catalogue.

FUNCTIONAL ABNORMAL OCCLUSION.*

By Norman G. Bennett, L.D.S., M.B., B.Ch.

I am afraid this communication is not a "paper," and that I shall not utilise all the time provided by the Secretary, but I venture to hope that if the opinions I express are sufficiently unorthodox, then I may succeed in provoking a discussion that will serve the purpose equally well or better. In the practice of orthodontics it is a great thing to have high ideals, but it is sometimes very undesirable to act upon them. It must happen to all of us that patients present themselves with some slight abnormality, and the question arises whether treatment is worth while. If it were the case that the degree of abnormality might be taken as a measure of the difficulty of treatment and the amount of time required, there need be few cases in which a slight abnormality would be left untreated, and the ideal result not obtained, but we know that this is not so. In some cases of fundamental abnormality such as a post-normal mandibular occlusion, we know that a perfect result can sometimes be obtained by an inclined plane to "jump the bite," with or without a slight widening of the maxillary dental arch. On the other hand, a partial rotation of a lateral incisor may require for its correction a somewhat elaborate fixed appliance to move other teeth in order to make correction of the lateral incisor possible, and also to rotate the lateral itself. The question then arises, is the game worth the candle? One could mention many other examples, such as a buccally misplaced lower molar, or an upper premolar which cannot quite take up its correct position in the arch.

But it is not so much these trivial abnormalities that I wish to speak about as the more fundamental errors in occlusion. We know that in cases of post-normal mandibular occlusion it is not so much the occlusion itself which may be a disadvantage to the individual, as the consequences of it, or other correlated conditions. Post-normal occlusion may be functionally quite as useful as normal occlusion, but we know that it is frequently associated with a narrow maxillary arch or with a deep over-bite, either of which may or may not be detrimental, or with superior proclination, or with retroclination of the upper central incisors and narrowness across the arch in the canine region.

The illustrations show you the models of two boys whom I have known from infancy. At various times I have had to consider whether it was desirable to interfere with nature, and have always decided to the contrary. Some of you will no doubt think that I decided wrongly.

Now I think we are too much inclined to regard what is usually recognised as normal occlusion as something which appertains to the human race throughout the ages. Ought we not rather to regard it as a phenomenon of the present day? We know that palæolithic and neolithic man had an edge-to-edge bite of the incisors similar to the anthropoid apes, and that the present form of occlusion in white races is a comparatively recent development. Primitive races like the negro have the lower incisors biting just behind the upper incisors, but I think you will find that the amount of overlap is less than in white races. As the mandible goes back,

* *Transactions* of the British Society for the Study of Orthodontics.

the degree of overlap increases. Have we any right to regard so-called normal occlusion as a fixed relationship or to say that a new relationship is not being gradually evolved? When we observe some of the other conditions constantly associated with post-normal occlusion—narrow maxilla, extreme proclination of upper incisors and so forth—we say that these are obvious abnormalities and must be regarded as pathological, although we do not know what the causes are. But in the two cases that I have shown there are no gross abnormalities. In the one there is slight overlapping in the upper incisor region chiefly on one side, and in the other there is retroclination of the upper incisors. In both there is a deeper overlap than usual, but I am not sure that we are justified in regarding that as pathological. In the former case the condition could only have been "corrected" on reasonable

J. D. S., Oct. 1916,
æt. $4\frac{1}{2}$

J. D. S., Jan., 1922,
æt. $9\frac{1}{2}$

J. D. S., Jan., 1927,
æt. $14\frac{1}{2}$

lines by moving all the upper cheek teeth backwards, and if this had been done to the extent of one unit, too much space would have been gained. In the latter the conditions could only have been corrected by moving forward the upper incisors and " jumping the bite " to the extent of one unit. I believe that the result would have been ugly. The boy has a long narrow face and the retroclination does not look unnatural. The result of treatment would have been proclination of the upper incisors to allow of

G. G. B., Oct., 1921,
æt. 11

G. G. B., Jan., 1927,
æt. 16½

correction of the occlusion of the cheek teeth, and a possibly unnatural forward position of the mandible, if it be assumed that the treatment would have been successful.

There is some fundamental difference between cases of post normal occlusion associated with superior proclination and superior retroclination. If the difference consists simply in tilting forwards or backwards of the upper incisors, then there should not be much difference in the difficulties of treatment. We know, however, that the second class is the more difficult to treat successfully. For instance, in cases of proclination, when it is decided not to advance the mandible a remarkably good result can often be obtained after extraction of the upper first premolars. But in cases of retroclination similar treatment would usually be disastrous. I think that the difference may consist in the relationship of the dental arch to the maxillary base, and that in cases of retroclination it is somewhat further back. This would also explain why they cannot be corrected by advancing the upper incisors and "jumping the bite," without producing some degree of proclination.

Now the point that I want to put before you is this. Are we justified in saying that cases like these two are abnormal or pathological and not evolutionary changes in a sort of half-way stage? There are two considerations of detail that bear upon this question. Both these boys have small upper canines. I think there is no doubt that the size of the upper canines (and perhaps the lower ones) relatively to the other teeth is a diminishing quantity. Moreover I think that small canines are most often found in children of high mental development and that they then erupt at an unusually early age. This earlier eruption is to be expected, because, as we know, the late eruption of the canines in anthropoid apes is correlated with their use as a sexual weapon. Again, if we are asked to say what is the most usual kind of slight abnormality to be found associated with normal occlusion and tolerably well developed dental arches, I think most of us would say some degree of imbrication or overlapping of the lower incisors. If this is true it indicates that the upper arch is gradually becoming too small for the lower, and Nature can best make the necessary correction by placing the mandible a little farther back. If this occurs to the extent of one unit, then there may be some overlapping of the upper incisors, but the diminishing size of the upper canines tends to neutralise this. I have advanced what you will probably regard as a fantastic hypothesis, but I would remind you that there is nothing necessarily fixed about so-called normal occlusion. Post-normal occlusion occurs in some of the lower animals. For example, I think the lemurs exhibit it, and it is interesting to reflect that they and the monkeys are closely related. Perhaps other members of this Society have cases similar to those that I have shown. I cannot help thinking that if we all kept our eyes open for cases of post-normal occlusion which are functionally effective and in which no correlated gross abnormalities exist, we might obtain material by which we might in some degree be able to picture the evolutionary changes which are still proceeding in man. We might even, while still regarding normal occlusion as a useful present-day working hypothesis, cease to regard it as an unalterable ideal.

Discussion.

The President, Mr. H. C. Highton, said the two cases which Mr. Norman Bennett presented at the last meeting and described as having functional abnormal occlusion, despite the fact of both being post-normal, opens up a wide field for discussion, and also the question of the desirability of treatment. These cases would come under Angle's Class ii, Division II, and are usually associated with retro-clination of the maxillary incisor teeth, a practically normal development of the chin and an absence of mouth breathing. I understood from the description of the cases by Mr. Norman Bennett that the profile was fairly normal, but I don't think he mentioned the question of mouth breathing or any pernicious habit that might have had an influence in producing the condition. The variation from the usual type of malocclusion associated with these cases appeared to be the absence of any inclination of the incisor teeth. In the first flush of enthusiasm in the treatment of cases of this type one was often tempted to embark on complicated treatment to obtain so-called normal occlusion, which we now realise as being rather what might be termed ideal occlusion, but which might not be exactly ideal for that particular case. It was often with this type of case that the operator was apt to get out of his depth, and to add considerable worries and troubles to the treatment without being able to accomplish any improvement, quite apart from the long duration of treatment and possible damage to the tissues. Hellman has pointed out in his articles that it is often advisable not to attempt treatment in certain cases, or at least to minimise it as much as possible, and I think the consensus of opinion in orthodontics is rather tending towards allowing the normal process of development to operate where a functional occlusion will be obtained without any marked degree of deformity. We recognise nowadays that there is such a thing as a natural disharmony, and that certain irregularities of the teeth do not necessarily constitute a deformity in the sense of being the result of a perversion of physiological processes. I suppose we must admit that retrogressive changes are taking place in the human face and dental arches, and that evolution is partially responsible, but the method of their occurrence is still a matter of great doubt and a subject that will require years of research. Animals are known to be born with deformities, but the law of the survival of the fittest usually applies, and only those that are free from any marked degree of deformity survive, whereas in man where jaws and teeth are not of anything like the same relative value, a survival of grosser types of deformities is common, and the extreme perversion of the function of mastication would appear to have an influence on the evolution of the masticatory apparatus. Treatment in these cases should include a knowledge of, and a complete elimination of the factors expressed in the deformity, but as yet we know so little of the etiology of mal-occlusion. By way of criticism, I should like to say that I made the query at the last meeting, which I should also like to repeat, that it appeared to me that the worst feature of the final models shown was the rather extensive overbite, and I should like to know whether Mr. Norman Bennett does not consider that this would have been very much improved if simple general expansion of both arches had been under-taken at an early age, also it appears to me that it would have relieved the slight crowding which has occurred in the incisor region. I should also like to ask Mr. Norman Bennett whether he had any particular reason at the back of his mind when these cases first presented themselves for refraining from treatment; and whether, had there been any inclination of the incisors, it would have altered his line of action. Mr. Bennett has brought forward an extremely important and inter-esting subject for discussion which involves many questions. I am sure there must be many members present who will wish to make remarks on these cases, and who perhaps have had experience in their treatment, so I trust we shall have a good discussion.

Mr. PITTS said he had not had the pleasure of listening to Mr. Norman Bennett's paper, but he had read it with great interest. He had brought a model of a case which he thought was a type of abnormal functional occlusion, and would show it on the screen. The child was a girl of about 12 years of age or a little over, who attended at the Royal Enfield Hospital some few years ago, and Mr. Bennett had actually seen her at the time, as she was one of the children they had had up at one of the prize examinations. The model (shown on the screen) showed the lateral occlusion. There could be no doubt about the condition being quite definitely post-normal, and it would be observed that there was a corresponding degree of maxillary retrusion, but that there was no bunching up of the upper incisors. He thought that point would be better brought out by seeing the actual models themselves. It would be seen from this model that there was no bunching up at all of those teeth. The lower incisors were not actually biting the palate, however. There was a definite space of about a millimetre, and he did not consider that there was any very marked degree of overbite. The next slide showed the photograph of the child in profile. He thought one must admit that, looking at the profile, one might be sure that there was some post-normal occlusion present. The chin was not very well formed, but actually it was not so noticeable in the child as it was in the photograph. In the photograph the head was rather bent forward, which he thought rather accentuated the condition. The case was one in which, if one were going to drag it into Angle's classification, one would have to say that it was Angle's Class ii, Division II, because the maxillary retrusion harmonised with the mandibular retrusion, but the upper incisor teeth were completely even. If any treatment were to be adopted for that case, the only possible thing would be to expand the upper arch anteriorly and push the teeth out in the hope that the lower jaw would follow. He felt quite sure that had such treatment as that been adopted the æsthetic results would have been good. The child did not suffer in any way from the condition. The upper incisors were not visibly abnormal : the lips were of normal length and were kept closed, and, as so often happened, she had just as good a working occlusion for the purposes of mastication as any other child with an ordinary normal molar occlusion. That was a good case, he thought, which corresponded exactly to the two which Mr. Norman Bennett had described, a case for which nothing at all should be done in his view. Mr. Bennett had raised a very interesting question as to whether those cases foreshadowed an evolutionary change, whether they were, as it were, the forerunners appearing out of due time now to such an extent that they could be called abnormal, but whether at some time in the far future they might become the relatively normal. It was very interesting to speculate as to what form evolution would take. The great thing about it was that no one could contradict the speculators, except perhaps someone who read the *Transactions* of the Society some fifty thousand years hence ; but he must say that although he had had the opportunity of seeing a lot of children, that was the only case of that type that he had seen at all. The so-called Class ii, Division II cases were not particularly common, but in all the other cases he had seen, there had been a very definite bunching up of the upper incisors, often of a rather ugly character, and calling for some correction. He had seen a great number of cases of post-normal occlusion in very young children—children of two or three or four years of age—but again he had never seen an upper arch that was well formed and well aligned just in the same way as the case he had described. If there was an evolutionary change going on one would certainly rather expect to find cases of that type more common, and yet it might be that his experience had been unfortunate. At any rate that particular one was the only one he had ever seen. Bearing on the other question, as to whether we might be arriving at a post-normal occlusion as the general thing, he

must say that he found himself increasingly adopting that as a working rule, and unless the profile very definitely showed a recession of the chin which was conspicuous, he usually ignored the post-normal occlusion. He diagnosed it as such, and then proceeded to ignore it for the purpose of treatment, and to treat the case as though it were one of superior occlusion only, and leave the post-normal occlusion to take care of itself. He believed that it provided the child with just as efficient a means of mastication as a normal neutral occlusion. He did not do that in every case, because there were many cases in which some treatment of the mandible was called for ; but in an increasing number of cases he did, because he found that in such a large number of cases the chin, if not perfect, was at least moderately well formed. It was, he thought, a rather remarkable thing that in the case of Class ii, Division II, where one got both normal molar occlusion just as marked as in Class ii, Division I, in nearly all cases the chin did appear to be quite well formed, and very rarely needed any treatment. In conclusion, Mr. Pitts said that he thought Mr. Bennett had done a great service in reading his paper, and in bringing those cases before the Society, because he thought that not only was it an interesting speculation, but it should sound a note of caution as to the necessity of treating all cases of post-normal occlusion merely because they were post-normal. Mr. Pitts then handed round his models.

Mr. Cale-Matthews said the paper which Mr. Norman Bennett had given was so practical a one that any discussion from a critical point of view was difficult. The cases he had selected as examples were, from the attitude he had taken, difficult for the listener to discuss. It must be remembered that both these boys had been under observation from early childhood, and we have not been given the opportunity of seeing any photographs which may have helped in forming an opinion. Mr. Norman Bennett assures us that both patients have long narrow faces and the profile is good despite the post-normal occlusion. It should be remembered that the models shown are on a flat plane and, as is usual, there is no means of judging the occlusal plane in relation to the base of the skull or the general facial aspect. This was exemplified in the two models and photographs which Mr. Pitts had just thrown on the screen in discussing the paper. There was a marked dissimilarity in the facial contour of the two photographs, but Mr. Cale-Matthews assumed that the photographs were taken at the same time ?

Mr. Pitts : Yes.

Mr. Cale-Matthews continuing : Cases of post-normal occlusion of the type shown by Mr. Norman Bennett would fail in treatment for permanency of correction unless a due regard was given to the occlusal plane as distinct from the post-normal occlusion. It would be found that there was an invariable tipping forward of the first permanent molars in the lower jaw and a lack of vertical growth in the premolar region, also an elevation of the lower incisors in that relation, and so far as he knew where treatment was undertaken to reduce the post-normal occlusion success was not obtained unless a reduction of the excessive curve was established. Combined with that, due care should be taken to observe the position of the superior canines ; a reversion in this type of case was often due to a narrowness in the canine region. These points have been brought out in some of the earlier orthodontic writings and particularly in Angle's earlier arguments, and only on those lines could one hope to attain permanent success in the treatment either of unilateral or bilateral post-normal occlusion cases. Had it not been that the programme for the evening was already full he would have brought forward several models which would have strengthened Mr. Norman Bennett's argument. Not only did he agree with him in leaving many of those cases untouched as far as the post-normal occlusion was concerned, provided always that the facial appearance was good, but in actual treatment unless there were other complications

he thought it often wiser not to interfere with good molar occlusion. Experience in the practice of the correction of abnormalities of occlusion impressed him with the danger of interfering with a really good molar occlusion, and particularly in those cases which might be described as on the border line of normal and post-normal occlusion. There was a marked difference in the second pair of models illustrated in the paper in regard to the amount of overbite and prominence, and also in the space between the superior canines. He quite agreed that it may have been too particular treatment to have attempted any interference with the lateral and central incisor into the more regular occlusion. In making a diagnosis of these cases and bringing the mandible into the correct occlusion it was necessary to be particularly careful to avoid the chin becoming a dominating factor in the facial occlusion. This was particularly noticeable, he thought, in the two photographs shown by Mr. Pitts. He thought the Society was indebted to Mr. Norman Bennett for bringing the subject before it, and he thanked him very much. There was much more to be said, many points to be discussed, and it would be quite easy to write another paper in reply which could bring forward many minor points which Mr. Bennett had purposely avoided. In connection with this type of case Mr. Bennett uses the following phrase: "There is some fundamental difficulty between cases of post-normal occlusion associated with superior proclination and superior retroclination." Most dental surgeons had learned what these were in the earlier teaching of Angle, and now they were trying to get away from that arbitrary classification, it was found they were opening up a very wide and difficult problem. The cases which Mr. Bennett had purposely avoided treating were those in which there was a narrow maxilla and well-developed but flattened mandible with post-normal occlusion. Those cases were the most to be dreaded; much more so than any individually displaced teeth coupled with a post-normal occlusion.

Mr. Pitts said if he might intervene again he merely used his "if" with regard to the evolutionary change suggested by Mr. Bennett without suggesting that evolution had come to a standstill.

Mr. Badcock said that whether or not retroclusion was going to become normal occlusion, it seemed to him a great deal more common than it used to be. He seldom entered an omnibus without finding at least one of the passengers the subject of that condition, and very often there were two or three. As to its treatment, he fully agreed with Mr. Bennett that there were cases where no treatment was necessary. He did not think they were very common, but he could recall one or two, and as a matter of fact he had one under his hands at the present time where the only treatment needed was the rotation of two twisted laterals. There was one little point in Mr. Bennett's paper which rather astonished him, and that was his statement that the removal of the first upper premolar in the case of Angle's Division II would lead to disaster. It had always seemed to him that those were particularly the cases where the extraction of the first premolar was the most successful, particularly if done early. If one extracted the first premolar as soon as it appeared the canine would fall back into place, and generally no other treatment was necessary. It might be that he had misread Mr. Bennett, or that he had not quite remembered what he had said. In conclusion, he wished to add his sincere thanks to Mr. Bennett for the paper, which was most stimulating, as Mr. Bennett's papers always were.

Mr. H. Chapman said that like Mr. Pitts, he was not in the fortunate position of hearing Mr. Bennett's paper, and he had only read it during the past week, but just before he did so he saw a child whom he had been treating for a couple of years, and had produced the condition more or less represented by "J.D.S." in the illustrations, and curiously enough he had advised that the treatment might cease at that particular point. He really mentioned that to show that he agreed with previous

speakers in believing that functional occlusion, even if it were abnormal, might be very satisfactory and perhaps be preferable to treatment to produce a functionally normal occlusion. The point which Mr. Badcock had referred to also occurred to him, and he wondered whether Mr. Bennett had said what he intended to say there—that was with regard to the extraction of the first upper premolars in cases of Class ii, Division II. He himself had treated several of those cases, especially in older patients, about 14 or 15 years of age, where the laterals were prominent, which was very frequently seen in these cases, by removal of the first premolars, either one or both of them, according to the conditions, and bringing back the canine and depressing the laterals so as to come into line with the central and canine. There was one other point to which he wanted to refer, and that was with regard to the smallness of the canines, not so much that he wanted to mention that, but he recalled that when he was making investigations into the histories of children where there were brothers and sisters in the same family, one being a normal occlusion and another in Class ii, Division I, the Class ii, Division I children were more brilliant mentally than the others, although the others were probably the more methodical and harder workers, and might succeed better in after life; but superficially it appeared that the others were more brilliant. He, too, wished to add his appreciation of Mr. Bennett's paper, and to say that anything he (Mr. Bennett) brought before the Society was always worthy of the most serious consideration, even though it ran counter to what might be regarded as orthodox.

Mr. SPILLER asked one question. What was the earliest recorded case he knew of in history of post-normal occlusion?

The following contribution from Mr. H. T. A. MCKEAG, of Belfast, was read:—

There is so much of the attitude of philosophic doubt about Mr. Bennett's paper that one requires to be careful in deciding what conclusions he would have to draw. It seems, however, safe to say that his main theses are: first, that we may cease to regard "normal occlusion" as an unalterable ideal; and second, that an evolutionary change is at work in man which tends to bring the lower arch further back in relation to the upper. With the first of these my only quarrel is that it is only necessary to make the hypothesis because the term "normal occlusion" is used instead of "ideal occlusion." Were it stated like this: That there are departures from ideal occlusion which do not call for treatment I should be in complete agreement, but I cannot see that a standard based on a quite arbitrary conception of ideal form can be established as "normal" for a functional structure such as the dentition. That subject, however, is too big for full discussion now. With the second thesis I find it impossible to agree. It seems to me that the evidence for this evolutionary change in the dentition towards a backward relationship of the lower arch, or of the mandible, is too slight. In the first place one may examine the statement that prehistoric man had normally an edge to edge bite. In a very narrow sense it is probably true, but I will make bold to say that it is even more probable that up to the age of, say, 20 an edge to edge bite of the permanent incisors was as much an abnormality then, and as much a departure from the average, as it is now. The edge to edge bite was established at a later age by a process of wear of the molar and premolar cusps and of the incisal edges, just as in our day it is established in the later stages of the deciduous dentition in many children, and even in the permanent dentition where the teeth are preserved long enough for the less intense wear to take effect. Even in this later stage, which of course I regard as equally normal with the earlier overlapping stage, there seems to be room for doubt as to whether the bite was actually edge to edge in a strict sense. It is not unlikely to have been as it becomes now, something like this rough sketch. I believe similar conditions of life would produce a similar adult average to-day.

The only other evidence in support of this second hypothesis is in connection with a tendency to a relative diminution of the size of the upper canines. I am not familiar with the material on which this is based, but the chain of reasoning from it contains, as I think Mr. Bennett will agree, some slender links, but there is one point where it seems to me that links are missing, and their place is taken by some very bold assumptions. I will quote verbatim: "If we are asked to say what is the most usual kind of slight abnormality to be found associated with normal occlusion and tolerably well-developed dental arches, I think most of us would say some degree of imbrication—of the lower incisors. If this is true it indicates that the upper arch is gradually becoming too small for the lower, and nature can best make the necessary correction by placing the mandible further back." First, is it necessarily true that this imbrication indicates that the upper arch is becoming too small for the lower. I do not agree any more than I would agree that the case of regular lower and spaced upper incisors, which I regard as normal in a large proportion of mouths, indicates the same conclusion. The even bolder assumption is then made that nature, in placing the mandible further back, is adopting an alternative and better method of making the necessary correction for the same defect. Even if one cuts out the word "best" I cannot think of a shred of evidence to support the assumption that we have here two kinds of adaptation to meet the same change. The conditions which produce post-normal occlusion (to use the common term) seem to me totally different from those which produce imbrication of the lower incisors. How then, denying the evolutionary theory, do I propose to account for such cases as Mr. Bennett has shown. I would say that they are two out of the enormous number of forms which the human dentition can take under the influence of the many and varied factors, hereditary, mechanical, nutritive, which go to the formation of every dentition. There is a difference only of degree between these and many cases which we are treating every day. To put a finger on one factor which from my experience is likely to have aided in preventing the second case illustrated (G.G.B.) from developing a gross proclination of the upper incisors, I would hazard the opinion that the lips are fully normal, in of course the functional sense. I have seen conditions closely resembling those in both sets of models produced from Angle's Class ii, proclination cases, as the result of orthodontic treatment which had failed to cure the close bite, but in which attention had been given to lip function. Obviously, in so frankly challenging Mr. Bennett's views I should produce evidence, but I regret that time does not permit the collection of such material as I have. Mr. Friel read a paper in the U.S.A. last year which contains, I believe, relevant evidence on the subject of the evolution of the individual dentition, and which should shortly be published. Need I say that I have been most intensely interested by Mr. Bennett's paper, and that I recognise the probability that it is merely because he has not presented an exhaustive study that I have found grounds for disagreement.

Mr. LINDSAY said Mr. McKeag had anticipated a criticism which he was going to make of Mr. Norman Bennett's paper, particularly, of course, in the latter part of it, and he would enforce that criticism by recalling that some time ago Mr. Humphrey, of Birmingham, gave a paper before the Society in which he described and submitted for inspection certain skulls from a Saxon burial ground at Bradford-on-Avon, and while in some of the older skulls the teeth, both upper and lower, were greatly rubbed down, and the bite was undoubtedly edge to edge, there were the very interesting cases of two skulls of comparatively youthful age in which the bite was not edge to edge, and there had not been that attrition which produced the forward movement of the mandible. He thought that probably supported Mr. McKeag's criticism of Mr. Bennett's assertion, although, of course, he did not forget in that matter that Mr. Bennett's statements had been reinforced

by the researches of Sir Arthur Keith. There was another interesting point mentioned by Mr. McKeag, and that was the comparative size of the canine teeth. It was known that there had been a reduction in the size of the canine teeth during the course of successive ages. Charles Darwin had called attention to that, but he thought there had also been a reduction in the size of the incisors and of all the other teeth, and he would like to express wonder as to whether there was really associated with the diminishing size of the canine teeth, that high degree of intelligence which Mr. Bennett noticed. He could not help wondering, when he had read that, what was the size of the canine teeth in Darwin, or Gladstone, or Disraeli. He rather thought that it would probably be found that in highly intelligent people of the present day the canine was a comparatively large tooth, and lastly he would ask Mr. Bennett if he seriously suggested that there was a lessening of the size of the maxilla not accompanied by a corresponding diminution in the size of the mandible, because if the diminution in size of the maxilla was of what was called a phylogenetic character, it would surely be accompanied by a corresponding diminution in the size of the mandible. He thought it would be very difficult indeed for anyone to say whether those cases with which Mr. Bennett had been dealing were pathological or evolutionary. Probably there would be an element of both. He had been rather astonished that Mr. Pitts, in his remarks, used the words : " If there is an evolutionary change taking place." Shade of Charles Darwin, was it to be supposed that the evolutionary process had stopped for a time ? He thought there was no doubt that there was an evolutionary change, but whether it was towards producing in the European or in the ordinary human species a post-normal occlusion was a very different thing. With regard to the size of the canine teeth, there was a Frenchman who investigated this question in connection with pigs. If the common domestic pig did not lose its tusks entirely they diminished very much in size, but when the pigs were turned into the woods and permitted to feed in a natural manner their tusks grew longer. Perhaps the same results might occur in man. If the human species were fed in a proper manner they might maintain the intelligence at the same time as they increased the size of the canine teeth. He thought there would be general satisfaction that there was at least a tendency to listen with a certain amount of patience to any one who came forward in an orthodontic society and suggested that it was not always necessary to introduce treatment in orthodontic cases ; and for that the Society certainly owed Mr. Norman Bennett its thanks.

Mr. Norman Bennett (in reply) said his main object in giving the Communication was to be stimulative, and, therefore, if he might accept what Mr. Badcock had said as the truth, he thought he had at any rate succeeded to that extent. It was extraordinarily difficult to reply to all the remarks that had been made, but he would do his best. He would start first of all in order with Mr. McKeag's written remarks. Mr. McKeag had to some extent, he thought, misunderstood his meaning. The Communication was not a paper ; there were not any assumptions in it at all ; there was very little in the way of argument ; he did not think there were any links in the chain, and if there were they were certainly weak ones. It was not an argument : it was a fantasy. It was only meant to consist of a few suggestions and ideas based on a certain amount of evidence, which might lead other people to bring forward further evidence in support, or destructive evidence in opposition, and to that extent he hoped that it had been successful. The President had asked about mouth breathing. The first boy, he thought, had never had enlarged tonsils or adenoids, and had never been a mouth-breather. The second boy had tonsils and adenoids removed at about 4 years of age, and was a mouth-breather at the time, and had remained a partial mouth-breather since ; but although he was a partial mouth-breather he had well-formed lips, which he thought

held the teeth in position. He did not agree that both those cases were Class ii, Division II. The first, he thought, was—if one used Angle's classification, but he did not think the second one was, because Division II, if it meant anything, implied retroclination of at any rate the central incisors, if not all four. There was certainly no retroclination ; there was no proclination ; those incisors were in a more or less normal position. It was Class ii, but he did not think it was any division at all. It was no use trying to put all cases into any kind of accepted classification. The classification had got to be made to fit the teeth, not the teeth made to fit the classification. As regards the question of overbite, the President had said that possibly some expansion might have corrected the overbite, and thereby benefited the cases. He might say in parenthesis, while he thought of it, that he was a little surprised really that more members had not said that he ought to have treated those cases. He was not at all sure himself that he ought not to have treated them. He had always refrained from doing so, and had hovered on the brink every time, and that had been the result ; but he was not at all sure that he was right. With regard to the overbite, Mr. Bennett asked the President whether, when he said "expansion," he meant lateral expansion or expansion generally, pushing the front teeth forward.

The PRESIDENT : Lateral expansion.

Mr. NORMAN BENNETT, continuing, said perhaps he had not quite understood the point, but he was not quite clear how lateral expansion could correct the overbite—he thought he had just seen the President's point. Possibly he might have expanded, but he refrained from doing so because in neither case was the maxilla really narrow ; it was perhaps a little narrower than normal, but it was not really narrow. The second point was, did overbite matter ? That was what he wanted to ask people. Where one had a deep overbite and the lower incisors impinged on the gum, obviously that mattered. Where the overbite impinged on the cingula, or upper incisors, and pushed them outwards, that obviously mattered ; but if it did not do either of those things what did it matter at all ? It might be argued that it impeded mastication. He did not think it did, because, although mastication in a child largely consisted of antero-posterior movements, in the adult it largely consisted of lateral movements, and he did not think the overbite made any appreciable difference. With regard to the profile and chin, both the boys had chins and mandibles which were rather sub-normal in size. They were boys with big heads and rather small mandibles, but this defect was not really noticeable in either case. If it had been he should have felt much more inclined to adopt treatment than he did in order to correct that appearance ; but he had felt rather that he would be aiming at converting what was natural to these boys into something that did not properly belong to them. Then as regards the first boy, he could only correct the occlusion (by bringing the mandible forward) if he first converted what was now a retroclination of the incisors into a proclination, because otherwise he did not think there would have been room for the mandible to come forward at all. With regard to the question of evolutionary change, he did not think Mr. Pitts had quite "got him." He did not mean to imply that those two cases indicated an evolutionary change. What he meant was that there was the possibility that there was an evolutionary change towards a post-normal occlusion, and that cases like those that he had brought forward indicated or illustrated a half-way condition. He did not mean that those cases, because they happened to be cases of post-normal occlusion without any obvious ill-effects of another kind, were necessarily what nature was aiming at, if he might use a teleological expression. He meant rather that, as Mr. Badcock had said, there appeared to be an increase in the number of post-normal occlusion cases, and that these two illustrated a rather unusual state of affairs, in which the post-normality was not accompanied by other ill-results.

With regard to the difference between Class ii, Division I, and Class ii, Division II cases, he would like to discuss that in the light of what Mr. Badcock, Mr. Chapman and Mr. Cale-Matthews had said. Mr. Cale-Matthews had reminded him of what he was sure was true, namely that the mandibular development, or at any rate the chin development, was more satisfactory in so-called Class ii, Division II cases than in Division I cases, and Mr. Badcock and Mr. Chapman disagreed with him when he said that the extraction of upper premolars was usually disastrous. He thought that depended upon what was regarded as disastrous. The usual state of the upper incisors in the Division II cases was, he thought, that the central incisors were very much retroclined, and the lateral incisors either slightly proclined or possibly in their normal position. The central usually sloped backwards, and the lateral usually sloped forwards, and the canine was usually more or less vertical. Now if one extracted a premolar, as Mr. Chapman said, and if one extracted it early, the canine very easily dropped back into the position of the premolar, and the lateral either would follow or could be made to follow and to fall into alignment with the central. That was what he regarded as disastrous, because he thought that there were few conditions so ugly as an extreme degree of retroclination of the upper incisors. He agreed that it was more ugly to have the centrals retroclined and the laterals proclined ; that was worse still ; but he thought that if they were all retroclined and looked as if they were falling down the patient's throat that looked ugly too. That brought him to a question he had raised in his little paper. He thought, and Mr. Cale-Matthews seemed to agree with him, that there was some fundamental difference between Class ii, Division I, and Class ii, Division II. One had to be dogmatic in teaching, and he had been accustomed to teach that the difference between the two was a question of the lips. If the upper lip was short, and the lower got in between the upper and lower teeth, then the upper incisors came forward and one got proclination ; and if, on the other hand, the upper lip was long and the lower lip did not get in between, then, as it were, the strength of the upper lip carried the central incisors backwards, and one got retroclination. That was nice, simple teaching. He thought it was largely wrong. He did not believe that that was the whole thing at all, because going back for a moment to the question of extraction, one knew perfectly well that in a Division I case if one extracted the first premolars one got not merely a satisfactory result, but in many cases a very good result indeed—a better result, he thought, than one ever got in Division II cases by extraction. The incisors and canines were put into alignment, and into a tolerably vertical position, whereas in a Division II case he did not think one ever got that result by extraction—not even a tolerable result. If that was correct, what did it mean ? He thought it meant that in Division II cases the whole of the maxilla was set further forward than it was in the case of Division I. The whole of the maxillary arch, the whole of the dental arch, was set further forward, and that was why one was faced with two difficult alternatives—the one of producing an unpleasant degree of retroclination by extraction or, on the other hand, of converting it into a proclination in order to get the mandible into position. With regard to Mr. Lindsay's remarks, he did not doubt that there were many highly intelligent people with large canines. Intelligence did not go with any particular form of teeth ; it might go with large canines or it might go with small ones. Nevertheless, he did think that he had observed that those children with small upper canines which erupted early were usually an intelligent type of child. That might be right ; he did not know. Other people might find something different ; but that had been his observation, and he ventured to say that it was confirmed by evolutionary ideas. Mr. Lindsay had given an example of pigs, but he would point out that while the boar had a canine which was partly used for purposes of digging up food and partly as a sexual

weapon, the canine of the apes was a sexual weapon; and therefore it was not unreasonable to suppose that as evolution progressed—and he agreed that it was still progressing—as mankind rose to higher levels, his canines became of less and less importance, and became of smaller size and erupted later, just as the canine of the chimpanzee erupts later than that of the gorilla, which was in some respects of a lower type. The question of the edge-to-edge bite was very interesting. As Mr. Lindsay had said, he had based what he said largely on the authority of Sir Arthur Keith. At the same time it was an interesting question whether the edge-to-edge bite was not usually found in skulls of mature age, but he did not think that the Anglo-Saxon skulls that were brought forward as an example would go very far to upset the theory, because the Anglo-Saxons were people merely of yesterday. The date, if he was correct in his history, was about 800 A.D. That was only 1,100 years, and reckoning three generations to a century that was about thirty-three generations. There was little difference to be observed after thirty-three generations of rats or rabbits. Thirty-three generations were nothing. When he talked about edge-to-edge bite he was talking about something very much farther back than that—sufficiently remote to allow time for evolutionary changes to take place. If those changes had taken place since Anglo-Saxon times he would say it was extremely remarkable; but it was sufficiently remarkable if it had taken place since, say, the Bronze Age or the Stone Age. He thought he had dealt with all the points except that raised by Mr. Spiller, who had asked a question which was most interesting: What was the earliest period in which cases of post-normal occlusion were found? He did not know. He wished Mr. Spiller could tell him. He presumed that in any skulls since Anglo-Saxon times—any mediæval skulls — there would be found plenty. Beyond that he did not know; he wished he did. It would be a most interesting point to investigate. He was very grateful to the members for having taken so much interest in such a very short and fragile communication. The point he especially wanted to bring out was that it was a mistake to get too much tied up by hypothetical notions and particular ideals, and to think that all cases that did not conform to canonical regularity required elaborate treatment.

A hearty vote of thanks was accorded to Mr. Norman Bennett for his paper.

THE Annual General Meeting of the Society was held at 11, Chandos Street, Cavendish Square, on Monday, December 6th, 1926. Mr. G. F. CALE-MATTHEWS (President) was in the chair.

On the recommendation of the Council, Mr. P. Sidney Spokes was elected an honorary member of the Society.

The PRESIDENT said that Mr. Spokes had occupied most of the positions it was possible to occupy as a dental surgeon, and had been in the forefront of dental politics and teaching for as long as he could remember.

The list of names of officers and members of Council as nominated by the Council was submitted. There were no private nominations, and the President declared those gentlemen whose names appear below to be duly elected :—

President, Mr. H. C. Highton; Immediate Past-President, Mr. Cale-Matthews; Vice-Presidents, Mr. B. Maxwell Stephens, Mr. A. T. Pitts and Mr. H. E. Marsh; Secretary, Mr. A. L. Packham; Treasurer, Mr. W. Ovey; Curator, Mr. L. F. Fouraker; Librarian, Mr. Bertram Samuel; Editor, Mr. Carl Schelling; Councillors, Mr. H. G. Watkin, Mr. J. B. Parfitt and Mr. H. R. Evans.

On the motion of the PRESIDENT, Messrs. Livingston and Fouraker were asked to serve again as auditors.

The HON. TREASURER, CURATOR, and SECRETARY each read brief

reports on the work of the year, all of which, after being proposed and seconded, were unanimously adopted.

The discussion upon Professor Brash's paper on "THE GROWTH OF THE ALVEOLAR BONE," postponed from the meeting of October 4th, was then taken.

VALEDICTORY ADDRESS.

The PRESIDENT then delivered his valedictory address. He said: The time has arrived when I must vacate the position to which you elected me just a year ago. I said at that time that a year soon passes, but I think this has been the one year to pass more quickly than any I remember. Perhaps the reason for this is the amount of interest the whole time has given. While the meetings have followed on their ordinary lines, the interest of the programme has been fully maintained. I think I should not exaggerate if I said more than that. The standard of papers has been high, and I am proud to have been in the presidential chair when Dr. Brash, the Professor of Anatomy in Birmingham University, presented his great paper. How far-reaching his work may be it is premature to estimate, but that it is history in the making the discussion of this evening proves. Thus we pass on to the commencement of another year with all its possibilities. From the general orthodontic point of view the great International Congress in New York easily takes first place in interest. This Society was well represented both in the programme and in general interest. We had a surprisingly good time, socially, intellectually and clinically, and I am sure no one regretted having spent his summer holiday attending that conference. I cannot refrain from mentioning one incident—in a conversation with one of the leading orthodontists in the States the topic was the general attitude of the dental profession and the public towards orthodontics in England, and a comparison with that in the States. It was difficult to explain the reasons for the apparent lack of interest here, but one was able to point out that earnest work had been and was being done, and that our insular conservatism may have had something to do with any lack. "Yes," said my friend, "I may say quite frankly that we take off our hats to England and Europe for their research."

I feel sure they will be grateful for the work which will be published as the result of this year's programme. It only remains for me to thank you all for the very splendid way in which you have supported the meetings and for the many kindnesses which have been shown me during the past year. In introducing my successor I welcome one of the stalwarts. Enthusiastic, modest, a good sportsman, we know that in Mr. Highton we shall have a president who will carry on the traditions of the chair, and I hope he will be blessed with health to preside at all our meetings.

The PRESIDENT then inducted into the chair his successor, Mr. H. C. Highton.

Mr. HIGHTON expressed his thanks on election.

Mr. HAROLD CHAPMAN proposed a vote of thanks to the retiring President (Mr. Cale-Matthews), which was heartily accorded.

This concluded the proceedings.

TREASURER'S REPORT.

I have the pleasure to report that the Society's income for the past year has been £201 11*s.* 5*d.*, of which £200 0*s.* 6*d.* represents members' subscriptions and the remainder interest on the deposit account. There is also an increment of £6 5*s.* on the Savings Certificates purchased last year. Against this the total expenses have been £172 6*s.* 10*d.*, leaving a credit balance of £29 4*s.* 7*d.* on the year's work. The Society's assets are: cash in hand and at bank, £55 9*s.*; cash on deposit (Prize Fund), £85; 200 National Savings Certificates present value £166 5*s.*, making a total of £306 14*s.*

BRITISH SOCIETY FOR THE STUDY OF ORTHODONTICS.

INCOME AND EXPENDITURE ACCOUNT, December 1st to November 30th, 1926.

STATEMENT OF ACCOUNTS.

1924-1925.			Income.			1925-1926.		
£	s.	d.				£	s.	d.
187	7	6	To Members' Subscriptions			200	0	6
5	1	8	,, Interest			1	10	11
9	10	0	,, Sale of *Transactions*			—		
12	15	3	,, Dr. Balance			—		
£213	15	5				£201	11	5

1924-1925.			Expenditure.			1925-1926.		
£	s.	d.				£	s.	d.
22	1	0	By Rent and Epidiascope			29	15	5
1	1	0	,, Extra Meeting			—		
36	9	7	,, Printing, General			28	10	8
26	4	5	,, ,, *Transactions*			33	0	6
20	2	6	,, ,, Education Comm. Report ...			—		
22	1	0	,, Reporting			22	1	0
3	0	9	,, Typing			1	2	6
4	17	11	,, Petty Cash, Cheque Book			2	8	4
3	9	0	,, ,, ,, Patients' Fares			—		
3	3	0	,, Refunded Subscriptions			1	1	0
0	6	9	,, Library Account			10	13	9
8	1	6	,, Museum Account			3	2	6
11	16	6	,, Refreshments			10	10	0
10	10	0	,, Honoraria			—		
30	0	0	,, Transfer to Prize Fund			30	0	0
10	0	0	,, Transfer to Reserve Fund			—		
0	10	6	,, Brokerage			—		
—			,, Loss on Belgian Exchange			0	1	2
						172	6	10
—			,, Cr. Balance			29	4	7
£213	15	5				£201	11	5

We have examined the Books and Vouchers and find the above Statement of Accounts to be correct.

L. F. FOURAKER.
A. LIVINGSTON.

The following letter and the two questionnaires printed on foolscap sheets were sent out to all members of the Society during the year 1925 :—

THE BRITISH SOCIETY FOR THE STUDY OF ORTHODONTICS

11, Chandos Street, London, W.1.

Investigations Committee.

Investigation of Orthodontic Etiology.

"Dear Sir (or Madam),

"The Investigations Committee has had its attention drawn to the probability that Orthodontic Etiology has not received the consideration it merits and that the causes assigned are frequently based on insufficient evidence and inquiry. The Committee considers this subject of great importance and well worthy of investigation which, to be of value, must be considered by a large number of persons who are specially interested in the work, such as Members of the Society.

"The Committee suggests that suitable cases for investigation are those families in which there are at least three children, one of whom has a normal occlusion; or in which all three children have similar occlusions, but the Committee has no desire to limit the investigation to such cases only.

"Questionnaires (one to be filled in by the dentist and the other by the parent) have been drawn up for this purpose.

"Two blank questionnaires of each kind are enclosed. A separate chart is to be used for each family. Where there are more than three children in a family extra charts should be used for that family. Each child should be given a number, and, in addition, each family a sign or a number.

"The Committee requests that the Charts, completed with models, etc., may be returned not later than the 30th November, 1925, addressed to me—76, Grosvenor Street, Grosvenor Square, London, W.1.

"Mr. A. L. Packham, the Hon. Secretary of the Society, will be pleased to furnish extra questionnaires on request being made to him at 79, Portland Place, London, W.1.

"Yours faithfully,

"B. Maxwell Stephens,

"*Hon. Secretary, Investigations Committee.*"

HISTORIES OF CHILDREN OF THE SAME FAMILY,

FOR THE PURPOSES OF INVESTIGATING THE ETIOLOGY OF MALOCCLUSION.

To be filled in by the Dental Surgeon. Each sheet may be used for three children. Relevant information, additional to that asked for, will be appreciated.

Dental Surgeon's Name— *Address—*

....

Take the children in the order of their ages.

	Child I.	Child II.	Child III.
1. Sign or number. To indicate family to which child belongs.			
2. Child's name or number and sex.			
3. Occlusion.			
4. Sitting height.			
5. Nose and nostrils. Obstruction { Right. Left.			
6. Lips.	Long, Medium, Short, Everted	Long, Medium, Short, Everted	Long, Medium, Short, Everted
Length of upper lip. Lip ridge.* Upper lip. Firm. Lower lip. Firm. Pendulous.			
7. Tongue.	Contact with palate	Contact with palate	Contact with palate
Habitual position.	Lack of contact with palate	Lack of contact with palate	Lack of contact with palate
Size. Shape. Strength.			
8. General condition of mouth.			
9. Condition of teeth. Cleanliness. Caries. Hypoplasia.			
10. Condition of gums.			
11. Natural spacing of deciduous teeth.			
12. Age of commencement of spacing of deciduous teeth.			
13. Attrition of deciduous teeth: Incisors. Canines. Molars.			
14. Premature or retarded eruption of deciduous and permanent teeth.			
15. Any other information.			
16. Father's occlusion.			
17. Mother's occlusion.			

Models and, when possible, photographs to be presented. (Also models and photographs of parents when possible.) Additional information to be written in the space above or on the back.

* A lip ridge is a ridge in mouth breathers upon the gum of the maxilla or mandible, usually both, indicating where the lip rests, that portion not compressed being swollen, either as a definite hypertrophy or an œdemia of the soft tissues.

HISTORIES OF CHILDREN OF THE SAME FAMILY.

Take the children in the order of their ages.

	Child I.	Child II.	Child III.
1. Sign or number. To indicate family to which child belongs.			
2. Child's name or number and sex.	M. F.	M. F.	M. F.
3. Race.			
4. Date of birth (age).	( )	( )	( )
5. Height.			
6. Weight.	Clothed. Unclothed.	Clothed. Unclothed.	Clothed. Unclothed.
7. Walked at.	Age. Early. Late.	Age. Early. Late.	Age. Early. Late.
8. Physical variations in infancy.			
9. Knock-knees, flat-foot or other changes.			
10. Ante-natal factors. (i) Father's health. (ii) Mother's health. (a) Mental. (b) Physical. (iii) Other factors. (iv) Normal birth or difficulties.			
11. Weight at birth.			
12. Length at birth and other measurements.			
13. Diet. 1st year: Breast fed	How long ? Vigorous. Medium. Feeble.	How long ? Vigorous. Medium. Feeble.	How long ? Vigorous. Medium. Feeble.
1st year: Artificial.	How long ? What foods ?	How long ? What foods ?	How long ? What foods ?
2nd to 6th years.			
After 6th year.			
14. Sweets.	Many. Few.	Many. Few.	Many. Few.
15. Fruit.	Daily. Irregular.	Daily. Irregular.	Daily. Irregular.
16. Mastication.	Vigorous. Medium. Feeble. Rapid. Slow.	Vigorous. Medium. Feeble. Rapid. Slow.	Vigorous. Medium. Feeble. Rapid. Slow.
17. Habits, i.e. sucking thumb, fingers, tongue, lips, etc. How long each day. Between what ages.	With or without jaw movement.	With or without jaw movement.	With or without jaw movement.

Additional information to be written in the space above.

18. Comforter. Used between what ages. How long used at one time. If used during sleep.	With or without jaw movement.	With or without jaw movement.	With or without jaw movement.
19. Breathing. Day.	Nose. Mouth. Both.	Nose. Mouth. Both.	Nose. Mouth. Both.
Night.	Nose. Mouth. Both.	Nose. Mouth. Both.	Nose. Mouth. Both.
If mouth breathing state 1. Possible cause. 2. Degree. 3. Age of onset. 4. Date when nasal breathing restored. 5. Which child suffered most, which least, and so on.	Constant. Partial.	Constant. Partial.	Constant. Partial.
20. Adenoids & Tonsils. Age at which suspected. Date of operation.			
21. Nasal obstruction.	Present. Yes. No.	Present. Yes. No.	Present. Yes. No.
Age of onset.			
22. Rickets.			
23. Disturbed nutrition. Give ages.			
24. Illnesses. Give ages of occurrence of each.			
25. General Health and physique. Type of exercise taken at different ages.			
26. Inherited characteristics.			
27. Ages of children older.			
28. Age of child.			
29. Ages of children younger.			
30. Father's date of birth. General health. Physique. Other details.			
31. Mother's date of birth. General health. Physique. Other details.			

Additional information to be written in the space above.

British Society for Study of Orthodontics.

Achner, C. A., 47b, Welbeck Street, W.1.
Ainsworth, N. J., 140, Harley Street, W.1.
Aldred, A. B., 88, Park Street, Grosvenor Square, W.1.
Allen, A. G., 128, Queen's Road, Bayswater, W.
Aubrey, H. P., 83, Portland Place, W.1.
Badcock, J. H., 140, Harley Street, W.
Barrett, R., 41, Harley Street, W.1.
Bell, A. W., 42, Devonshire Street, W.1.
Bennett, N. G., 50, Brook Street, W.1.
Blaaberg, C. J., 29, Queen Anne Street, W.1.
Boutwood, R., 23, Welbeck Street, W.1.
Bowes, J. A., 28, South Side, Clapham Com., S.W.
Bragg, R. N., 60, Barrington Road, S.W.9.
Briault, E. H. L., 145, Finchley Road, N.W.
Bull, F. B., 58, Wimpole Street, W.1.
Bulleid, W. A., 1, Burlington Gardens, W.1.
Buxton, J. L. Dudley, 38, Harley Street, W.1.
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Campkin, H. T., 71, Harley Street, W.1.
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Clarence, Thomas H., 24, Upper Wimpole St., W.1.
Clarke, J. F., 52, Shaftesbury Avenue, W.1.
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Coe, W. E., St. Norman's, Streatham Hill, S.W.
Crampton, Miss E. F., 108, Chatsworth Road, Willesden Green, N.W.2.
Cregan, T. C., 41, Wimpole Street, W.1.
Cribb, H. E., 15, Stratford Place, W.
Cross, A. B., 11, Buckingham Gate, S.W.1.
Curtis, G. H., 2, Weymouth Court, Weymouth Street, W.1.
Davis, E. D. D., 46, Harley Street, W.1.
Doherty, J. W., 140, Harley Street, W.1.
Doubleday, F. N., 48, Welbeck Street, W.1.
Dowsett, E. B., 118, Gloucester Place, Portman Square, W.1.
Eady, B., 29, Devonshire Place, W.1.
Evans, H. R., 158, Strand, W.C.
Everard, C. C., 87, Worple Road, Wimbledon, S.W.19.
Farris, C. D., 42, Burnt Ash Road, Lee, S.E.12.
Fouraker, F., 29, Central Hill, Upper Norwood, S.E.19.
Fouraker, L. F., 29, Central Hill, Upper Norwood, S.E.19.
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Fry, W. K., Guy's Hospital, S.E.1.
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Garrow, A., 115, Harley Street, W.1.
George, Miss V. H., 14, Weymouth Street, W.1.
Goldie, G. J., 14, Upper Wimpole Street, W.1.
Grayson, J. K., 76, Grosvenor Street, W.1.
Green, W., South View, 10, North Common Road, Ealing, W.
Greenish, V. A. F., 51, Welbeck Street, W.1.
Hammell, D. H., 19, Upper Wimpole Street, W.1.
Harborow, G. J., 38, Woburn Square, W.C.1.
Henry, C. J., 78-79, King William Street, E.C.4.
Henry, P. F., 79, King William Street, E.C.4.
Highton, H. C., 17, Harley Street, W.1.
Hopson, M. F., 7, Harley Street, W.1.
Humpherson, Mrs. V. W., 23, Eccleston Street, Victoria, S.W.1.
James, W. W., 2, Park Crescent, Portland Place, W.1.
Jennings, E. A., Courtfield Lodge (Top Queen's Walk), Castlebar Hill, Ealing, W.5.
Johnson, A. W., 71, Grosvenor Street, W.1.
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Jones, Wm., 2, Colosseum Terrace, N.W.
Keith, Sir A. (Honorary Member), Royal College of Surgeons, Lincoln's Inn, W.C.2.
Knaggs, S. A., 4, Cavendish Place, W.1.
Knowles, C. H., 47, Rosslyn Hill, N.W.3.
Lacey, A. G., 19, Harley Street, W.1.
Lane, E. G., 90, Park Street, W.1.
Lawrence, F., 167, Whitechapel Road, E.1.
Levien, L., 11, Welbeck Street, W.1.
Levin, H., 79, Harley Street, W.1.
Lindsay, Mrs. L., 23, Russell Square, W.C.1.
Lindsay, R., 23, Russell Square, W.C.1.
Livingston, A., King's College Hosp. Med. School, Denmark Hill, S.E.5.
Lockett, A. C., 75, Grosvenor Street, W.1.
McBride, J., 26, Duke's Avenue, Muswell Hill, N.
McKechnie, J. D., 29, Queen Anne Street, W.1.
McMahon, G. E., 19, Upper Wimpole Street, W.1.
Malleson, H. C., 30, Thurlow Rd., Hampstead, N.W.
Mallory, F. R., 30a, Wimpole Street, W.1.
Marsh, L. R., 24, Devonshire Terrace, Lancaster Gate, W.2.
Marston, A. T., 74, South Side, Clapham Common, S.W.4.
Matland, Miss A. M., 75, Moorgate, E.C.
Matthews, G. F. Cale-, 6, Cavendish Place, W.1.
May, W. J., 24, Upper Wimpole Street, W.1.
Mellersh, W. F., 9, Harley Street, W.1.
Metcalf, H. F., 392, Upper Richmond Road, S.W.15.
Mendleson, B., 53, Queen Anne Street, W.1.
Messenger, H. L., 47, Rosslyn Hill, N.W.3.
Morris, C. S., 88, Park Street, W.1.
Newton, S. B., Brooklands, Uxbridge Road, Acton Hill, W.3.
Northcroft, G., 115, Harley Street, W.1.
Olver, S. H., 42, Devonshire Street, W.1.
Ovey, W., 5, Orsett Terrace, W.2.
Packham, A. L., 79, Portland Place, W.1
Patterson, N. M., 29, Upper Phillimore Place, W.8.
Pavitt, P. G., 57a, Wimpole Street, W.1.
Payne, J. L., 18, Portland Place, W.1.
Payne, A. Ll. S., Beechcroft, Colney Hatch Lane, Muswell Hill, N.10.
Pearce, F. J., 57a, Wimpole Street, W.1.
Phillips, E., 1, Frognal, N.W.3.
Pitts, A. T., 22, Wimpole Street, W.1.
Pollitt, G. P., 50, Brook Street, Hanover Square, W.1.
Possener, Miss M., 143, Fordwych Road, N.W.2.
Power, H. L., 270, Earl's Court Road, S.W.5.
Pritchard, G. B., 18, Portland Place, W.1.
Revill, W. E., 202, High Street, East Ham, E.6.
Riddett, S. A., 4, Bentinck Street, W.1.
Rilot, B. A., 22, Wimpole Street, W.1.
Rilot, C. F., 22, Wimpole Street, W.1.
Roberts, C. W., 60, Harley Street, W.1.
Rubra, C. H., 66, Crouch Hall Road, N.W.8.
Rushton, W., 32, Harley Street, W.1.
Salt, H. O., 24, St. Thomas's Street, London Bridge, S.E.1.
Samuel, B. B., 76, Wimpole Street, W.1.
Sargent, V. F., 7, Harley Street, W.1.
Schelling, C., 37, Cavendish Square, W.1.
Scott, P., 24, Park Crescent, Portland Place, W.1.
Shaffner, B. M., 41, Wimpole Street, W.1.
Sharp, P. B., 76, Grosvenor Street, W.1.
Shore, H. D, 85, Gloucester Place, Portman Square, W.1.
Sirey, J. S., 69, Gondar Gardens, West Hampstead, N.W.6.
Skipper, T. G., 52, Welbeck Street, W.1.
Spiller, J. E., 62, Worple Road, Wimbledon.
Steadman, S. F. St. J., 9, Welbeck Street, W.1.
Stephens, B. M., 76, Grosvenor Street, W.1.
Strickland, J. H., 1, Mount Street, Berkeley Square, W.1.
Sturridge, E., 29a, Wimpole Street, W.1.
Sutherland, Miss J. H. M., 14, Weymouth Street, W.1.
Taylor, Miss M. M., 6, Cavendish Place, W.1.
Tebbutt, E. S., 30, Finsbury Square, E.C.2.
Thew, W., 14, Upper Wimpole Street, W.1.
Thomson, G., 142, Harley Street, W.1.
Tobias, Miss A., 55, Minster Road, N.W.2.

London Members—*continued.*

Torrance, T. A., 29, Queen Anne Street, Cavendish Square, W.1.
Wallace, Dr. J. Sim, 150, Harley Street, W.1.
Webb, W. T. Clarkson, 41, Wimpole Street, W.1.
Williams, P. Lloyd, 128, Harley Street, W.1.
Wright, J. S., 37, Cavendish Square, W.1.
Wright, L. D., 1, Wellfield Avenue, Muswell Hill, N.10.

Provincial Members.

Berkshire.
Butchart, J. S., High Mead, Bolton Crescent, Windsor.
Dickens, D. T. G., Wellington House, 175, King's Road, Reading.
Parfitt, J. B., 179, King's Road, Reading.
Philpots, M., 14, High Street, Windsor.

Bucks.
Hudson, J. A., 67, High Street, Aylesbury.
Pitt, E., Brandhoek, Gerrard's Cross.

Cheshire.
Hughes, T. M., Lister House, Broomfield Lane, Hale, Altrincham.

Devonshire.
Dagger, H., St. Paul's Road, Newton Abbot.
Lake, C. P., 22, Sauthernhay West, Exeter.

Gloucester.
Claremont, L. E., 5, Rodney Place, Clifton, Bristol.
Johnson, W. T., 22, Park Street, Bristol.

Hants.
Baldwin, Sir Harry, Castle House, St. Helen's, Isle of Wight.
Bascombe, E. D., Melford Lodge, Bourne Avenue, The Square, Bournemouth.
Crane, W. A., Melford Lodge, Bourne Avenue, The Square, Bournemouth.
Morris, L. F., West Moor, Poole Road, Bournemouth.

Herts.
Charles, S. W., Devonia, Rickmansworth.
Fisk, S. W., Street Lodge, Essex Road, Watford.

Kent.
Denham, N., 29, Albemarle Road, Beckenham.
Edey, G. R., 153, High Street, Bromley.
Lees, C. B., Boyne Road, Tunbridge Wells.
Mason, E. N., Sandown, 306, Broadway, Bexleyheath.
Pain, A., 17, Earl's Avenue, Folkestone.
Smith, J. Stuart, 3, Queen's Road, Tunbridge Wells.

Lancashire.
Campion, D. H., 264, Oxford Road, Manchester.
Campion, G. G., 264, Oxford Road, Manchester.
Mountford, C. H., 31, Rodney Street, Liverpool.
Robb, G. C., 22, Hoghton Street, Southport.
Watkin, H. G., 95, Durning Road, Liverpool.

Leicestershire.
Downing, F. J., 165, London Road, Leicester.
Rowlett, A. E., 165, London Road, Leicester.

Middlesex.
Andrews, Miss F. M., 4, Creswell Road, East Twickenham.
Edgar, N., 39, London Road, Enfield.
Fernie, J. G., Holmleigh, Murray Road, Northwood

Norfolk.
Bryan, H., 26, St. Giles' Street, Norwich.

Northampton.
Wood, B. J., 7, London Road, Kettering.

Northumberland.
Jameson, A., 18, Jesmond Rd., Newcastle-Tyne.
Jameson, J. T., 12, Windsor Cres., Newcastle-Tyne.
Markham, L. M., 1, Victoria Sq., Newcastle-Tyne.
Richter, L., 1, Newgate Street, Morpeth.

Staffordshire.
Commander, E. N., 11, Aldergate, Tamworth.

Surrey.
Croke, A. E., Sussex House, Guildford.
Kelham, Miss M. M., 29, Park Hill, Carshalton.
Mayer, J. W., Stedham House, Surbiton Hill.
Newbald, L. J., 150, Carshalton Park Road, Carshalton.
Pearce, R. M., 21, Oil Mill Lane, Kingston-on-Thames.
Smythe, Miss K. C., The Haven, Knowle Road, Dorking.
Stordy, T., 42, Claremont Road, Surbiton.
Townley, S. G., Knoll Road, Camberley.

Sussex.
Badcock, G. W., 32, Brunswick Place, Hove.
Davie, M., 6, Carlisle Parade, Hastings.
Gray, N., 13, College Road, Eastbourne.
Lowe, E. W., 6, Brunswick Place, Hove.
Marsh, H. E., 1, Cantelupe Road, Bexhill.
Middleburgh, H., 44, Sackville Road, Hove.
Spokes, S. (Honorary Member), Castle Place, High Street, Lewes.
Visick, H. C., The Wolds, College Road, Eastbourne.

Warwickshire.
Matthews, T., 42, Sheep Street, Stratford-on-Avon.
Roe, S. H., 60, Newhall Street, Birmingham.

ISLE OF MAN.
Douglas, M. N. M., 1, Albert Terrace, Douglas.

SCOTLAND.
Campbell, W. G., 27, Tay Street, Dundee.
Wilson, A. G., 9, Sandyford Place, Glasgow, W.

IRELAND.
Friel, S., 3, Fitzwilliam Place, Dublin.
McKeag, H. T., 2, College Gardens, Belfast.
Stirling, Mrs., 13, Upper Fitzwilliam Street, Dublin.

Members Residing Abroad.

AUSTRALIA.
Parker, G., 181, Edward Street, Brisbane.
Wilkinson, W. S., 156, Collins Street, Melbourne.

INDIA.
Balendra, W., Kalyani, Kanatta Road, Colombo, Ceylon.

NEW ZEALAND.
Newell, C. J., 96, Oxford Terrace, Christchurch.

SOUTH AFRICA.
Stein, M., 18, Darling Street, Cape Town.
Toit, J. J. du, 11, Leevenovet Road, Tambverskloof, Cape Town.

BELGIUM.
Layton, G., 12, Rue Belliard, Bruxelles.

FINLAND.
Johanson, C., Wladimirsgalan 16, Helsingfors.

ITALY.
Winderling, Prof. A. M., Via Manzoni 45, Milan (Corresponding Member).

SWITZERLAND.
Dreyfus, S., 16, Grand Pont, Lausanne (Corresponding Member).